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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Foundry Technical Institute, Meek's Road, Falkirk *(Telephone 333).*

Forthcoming Events.

Institute of British Foundrymen.
JUNE 17-20.
Annual Convention at Middlesbrough.

Economical Manufacture.

As we have ourselves pointed out from time to time, there is plenty of choice for anyone who would find a universal panacea for the troubles of British industry. Amalgamation, rationalisation, salesmanship, advertising, safeguarding—the list could be indefinitely prolonged, but it is always more or less the same list and hence sufficiently familiar. If these remedies could be set aside as worthless, they would need to trouble us very little. Unfortunately, or fortunately, according to the point of view, they are all of some real value, all with a genuine contribution to offer, and there lies the danger. It is a twofold danger, because, in the first place, the advocates of any one of these methods are as a rule wilfully blind to the merits of the rest, and in the second place because they—the advocates—lose sight of the end in their enthusiasm for the means. As an example, it is to be feared that in some quarters tariffs are apt to be regarded as a substitute for industrial efficiency instead of a means to it.

The touchstone in these matters must be economical manufacture. If an innovation or a development does not promote economical manufacture, then it has no value. Thus, there is no special value in large-scale manufacture *per se*. Unified control and efficient management, resulting from large-scale manufacture, will probably induce economy in manufacture, but this end is not achieved by mere size in the producing unit. Certain classes of goods are eminently suited to mass production; others depend entirely on their individuality, and there is likely to be room for the large unit and the small in the industrial future.

Economical manufacture involves manufacture at a competitive price. This does not necessarily mean a price lower than any other on the market, but rather a combination of price and quality which when taken together are superior to any available alternative. Moreover, the price must be internationally competitive. Home competition may be virtually ruled out by large-scale combination; but foreign competition remains, and it must be met. It seems improbable that we shall be able in Great Britain to meet it by lower wage rates, especially as it has been demonstrated that the popular idea of starvation wages on the Continent is largely fallacious. It also seems improbable that the price of raw materials in the iron and steel trade will afford much more relief, if we compare the figures ruling with those of the pre-war period. Economy in manufacture thus resolves itself into a problem for solution by management. By means of specialisation and of improved equipment and methods generally, it is possible to diminish overhead expenses and so substantially to reduce manufacturing costs. It is to such methods as this that an efficient management looks when the need for economy in manufacture becomes urgent, not to external and capricious forces, not to lowered wages or neglected conditions. It has been demonstrated repeatedly that very low production costs can and frequently do go hand in hand with high wages and good working conditions; and very low production costs mean economical manufacture and a competitive price.

Technical Slogans.

At the Cleveland Convention of the American Foundrymen's Association, sessions were devoted to such themes as "Personnel Management," "Value of Sales Analysis and Market Research," and "Neatness and Cleanliness as Aids to Foundry Operation." The method of handling these subjects was peculiarly American and in general savours of "uplift." Usually, the Papers can be designated as basically trite, but embellished with smart and forceful platitudes. For example, one speaker defined the work of the staff manager as "one designed to make people more successful." This in contradistinction to the *but* of manufacturing, which is to make successful products. Also typical is the assertion that "the greatest endurance contest in the world is getting a new idea into any factory." Or again, "Show the man that, if he will manage in his home as the company must manage in its work, he will make money in his home." As a final example, we would cite one of the numerous numbered collections of platitudes. This particular one represents six cardinal laws underlying employment in a certain large American organisation. They are: (1) Be clean and orderly; (2) Take good care of property, equipment and materials; (3) Follow instructions to the letter; (4) Work well from whistle to whistle; (5) Work every day and let the foreman know if anything prevents, and (6) Work well with others.

The whole of the above appeals to us to be somewhat too closely allied to slogans to be of real lasting benefit—this, of course, from the British point of view. Slogans are detestable affairs when logically examined, as they are expressly designed to make people accept something without adequate thought. From the American point of view, however, we should imagine that the authors are doing their best to be exempt from any accusation of arguing from the particular to the general, but the "general" is to our mind a little too "general" so as to border on the platitudinous. The Americans have problems which are entirely different from European. For a long period they have experienced a shortage of workers, and the background of much of their decorative industrial excrescences, such as "vocational suitability," "personnel management," "group insurance schemes," and "welfare," is, in essence, an activity designed to attract and maintain a satisfactory body of workers.

We hope that the long-established British custom of utilising after-dinner speeches and presidential addresses for industrial uplift will be continued, and that such matters as we have outlined will not permeate the proceedings of technical associations.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The Poumay Cupola.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Referring to Mr. Cameron's discussion of the Poumay cupola in your issue of May 8, I remember talking over the gas analyses with him on my recent visit, and I note that he still publishes these analyses. I should like to ask Mr. Cameron again, through your columns, why, for instance, in Table III the average carbon dioxide and oxygen of 13 per cent. shows an average carbon monoxide of 10.5 per cent., whereas the well-known gas-producer relationship would demand 13.9 per cent.? Likewise, the average values after the change to the Poumay cupola give 18.4 per cent. carbon dioxide and oxygen, which would demand 4.1 per cent. carbon monoxide instead of the 0.1 per cent. shown in Mr. Cameron's table.

It appears to me that there is either excessive oxidation of iron going on or else the gas analyses are not correct. I believe the latter is true, for certainly no foundry could use 10 per cent. of the oxygen in oxidising the cupola charge and live.—Yours, etc.,

JAMES T. MACKENZIE.

American Cast Iron Pipe Company,
Birmingham, Ala., U.S.A.
May 24, 1930.

Middlesbrough Convention Fund.

Below we detail the third list of subscriptions to the above fund, which now totals £310 12s. 6d.

	£	s.	d.
Amount previously acknowledged	287	7	6
Brightside Foundry & Engineering Company, Limited... ...	5	5	0
George Brown & Bros.	3	3	0
Spermolin, Limited	3	3	0
Thos. W. Ward, Limited ...	3	3	0
Adaptable Moulding Machine Company, Limited	2	2	0
N. Downing & Sons, Limited ...	2	2	0
Beecroft & Partners, Limited...	2	0	0
MacNays, Limited	1	1	0
Reay Brass Foundry Company, Limited	1	1	0
Byron Brodie	0	5	0
	£310	12	6

John Wilkinson Memorial Medal.

The results of the recent examination held for the Junior Section of the Institute of British Foundrymen, Lancashire Branch, have just been announced as follow:—

Silver Medal.—B. Haigh, apprentice moulder, Metropolitan-Vickers, Limited.

Second Prize.—E. Sutcliffe, draughtsman, Hy. Wallwork & Company, Limited.

Third Place.—J. Holmes, apprentice moulder, Planet Foundry Company.

The following candidates, who received over 50 per cent. of marks, have been highly commended:—A. Thompson, assistant chemist, Messrs. Beyer, Peacock & Company; A. Fox, apprentice moulder, The Vaughan Crane Company, and G. H. Cooper, apprentice moulder, at Metropolitan-Vickers, Limited.

The examination this year took the original form of a Paper in which the questions had all the answers provided, but out of the three provided in each case only one was correct, and the candidates had to select this from their knowledge and experience.

The competition is held each year for the purpose of commemorating the life and work of the father of the iron founding industry in this country, John Wilkinson.

I.B.F. Branch-President.

SCOTTISH SECTION.

Mr. James Miller, who has been elected President of the Scottish Branch, has had an extensive and varied experience in foundry work. He served an apprenticeship as a moulder in the foundry of the Steel Company of Scotland, Limited, at the Hallside Works, Newton, near Glasgow, afterwards serving for two years as an improver in the drawing office. Mr. Miller later joined the firm of John Shaw & Company, Maryhill Iron Works, Glasgow, as assistant foundry manager, a post which he held for some seven years. He then went to the Carron Company, Falkirk, as manager of the high and low foundries of that company. Later he was offered and accepted the position of foundry manager with his old firm, John Shaw & Company, and remained in that position for twelve years. It was during this period that the firm was converted into a limited liability company and the name changed to Shaw (Glasgow), Limited.

MR. JAMES MILLER.

Mr. Miller next became connected with the firm of Rennies Steel Castings Company, Limited, of Glasgow, whose main business was light general steel castings and locomotive work, but family troubles arose and the firm eventually closed down.

In October, 1920, Mr. Miller was appointed foundry superintendent at the Renfrew works of Messrs. Babcock & Wilcox, Limited, and he is still occupying that position, which involves the direction and control of grey iron, malleable cast iron and steel foundries, turning out about a thousand tons of castings per week.

Mr. Miller has been a member of the Scottish Council for some time, and he takes a very live interest in the juniors and matters appertaining to the training of foundry apprentices.

Iron and Steel Trades Inquiry.

In the House of Commons recently, Mr. MacDonald, Prime Minister, informed Mr. Hoffman that the report of the Committee of Inquiry into the iron and steel trades was in the printers' hands, and he expected to receive it in the next few days.

Replying to supplementary questions, Mr. MacDonald said that a very valuable investigation had been made as to the wages and conditions in Continental steelworks. He had given instructions that that part should be published. When he had read the whole report, if it was at all possible to publish it, it would be published.

Random Shots.

A correspondent last week sent me a cutting from a North-Country newspaper, that I should be tempted to reproduce in full, were it not that I am unable to make the necessary acknowledgments, the name of the sheet in question having been suppressed, perhaps from motives of local patriotism! It is a brief article entitled "The Ironworker," and its style is positively lyrical. The writer, having referred to the "stoical determination of the fisherman and the sanguine spirit of the miner" (I suppose "sanguine" was not a misprint for a slightly longer word?), asks "what of the ironworker?" There follows a regular prose-poem, all about daily dallying by molten streams, and "darkness made all the more grim by the fitful flashes of the furnace flames."

* * *

Having thus described the background, this artist proceeds to sketch in his central figure. And the thing that seems to have struck him most forcibly about the ironworker's appearance is his *can of tea.* "Yes," he says, "the can holds sway despite the challenge of the thermos flask." [My own experience is that the average life of the domestic thermos flask is about a fortnight, and half that in the picnic season, and I fancy it might be an expensive item of equipment for a moulder. Besides, a thermos is a peculiarly awkward thing to carry.] "And despite the challenge of excellent beer," he continues, "tea prevails as the favourite beverage." I feel inclined to invite correspondence on the subject, being anxious to know whether, in your opinion and experience: (*a*) tea really is the favourite beverage of the ironworker, and (*b*) if it is, whether the reason does not lie precisely in the fact that the "challenge of excellent beer" doesn't exist nowadays!

* * *

I myself culled one particular gem from the provincial Press last week. A gentleman, who signed himself "Safety Last," wrote indignantly to the editor protesting that the attitude of the average employer in this country makes any "Safety First" movement a sheer farce. Now I daresay there are retrograde employers in these matters—employers who commit all the crimes of which this gentleman accuses them, such as being content to obey the letter of the law and leaving the rest to the insurance companies. But I would hesitate thus to attack them publicly were my grounds for doing so no better than those of Mr. "Safety Last." For his reason was that he had *offered his services as Safety Officer to some four hundred employers in this country and not one of them would give him a job!* Nothing like hanging your grievances out to air, is there?

* * *

MARKSMAN'S BULL'S-EYES.

The man who said he was a citizen of no mean city could not have hailed from Aberdeen.

Plenty of girls give half-a-crown for a bob these days.

Licences are of three kinds, and all of them fatal—liquor, motoring, and marriage.

One of our most sprightly gossip-writers has it that you can tell a woman's age from her diamonds. In that case, why aren't our wives more grateful to us for endowing them with the secret of perpetual youth?

MARKSMAN.

The Training of Foundry Apprentices.*

By W. R. D. Jones.

With the introduction of scientific methods in the foundries of our overseas competitors, a small but important migration of our skilled craftsmen to foundries in other countries, the more stringent inspection in vogue, the more expensive materials in use, resulting in the greater loss through defective castings, wasters, and bad workmanship, and, finally, a necessity for keeping costs down to a minimum consistent with quality and a reasonable profit in the face of the severe competition of to-day, all point to the urgent necessity for doing everything possible to make our young men fit to carry on.

The first question that arises is the type of boy to be encouraged to enter this trade—still one of the most important, interesting and fascinating of all the crafts. With the present scheme of juvenile education, when boys have advantages their fathers never had, the trade can expect a boy to have had a sound secondary school education and preferably to have reached matriculation standard. Unfortunately, the majority of parents, if they consider their boy at all smart, think at once of a "clean job"—in other words, a "collar-and-tie" job, and think it quite unbecoming for the lad to learn a trade. This is a great mistake, because the foundry trade opens up splendid opportunities for the boy of even average ability and certainly for the smart lad—providing he is not work-shy. This neglect of the various crafts is a very serious matter, and unless remedied soon will be calamitous. The general public should be informed of the opportunities awaiting the right type of boy in industry.

Having obtained the apprentice, his practical training should consist of learning to (1) make the pattern, (2) make the mould, (3) make the casting, and (4) make a profit. After completing his time the apprentice could make his decision as to which branch of the four he will adopt. It is bound to be an advantage for the apprentice to spend some time at each branch, because if he finally becomes a patternmaker he will have some knowledge of the difficulties of the moulder or the caster and will make a pattern which will permit of easy manipulation. If he goes finally into the office he can make a reasonable quotation, and if the job be not profit making he will realise that he himself is probably to blame for having quoted too low and he will not lay the blame on the foundry.

Apprenticeship Period Control.

During his apprenticeship the boy should be under the personal control of the manager, and after a certain time under the foreman of each branch, should be moved along. He should be made to work hard and not waste his time, because if a youth be not trained in hard work between 16 and 19 years of age he will never be any good. His time should not be wasted by making him an errand boy or anybody's devil and his time is too valuable to be spent in making tea or preparing meals—he should be at his trade. If he be not diligent and hardworking, his indentures should, for the sake of the trade, be taken away after a fair trial. The attitude to adopt is not so much as to make a boy into a good foundryman, but rather to see that the foundry trade benefits by the continual supply of well-trained young men.

Anything that is likely to make an apprentice a better craftsman should be done, and it is necessary to consider the educational training of an apprentice which shall supplement his practical training. There is no doubt at all that "science in the foundry" has become an accomplished fact. Among some of the more recent and rapid developments of foundry practice may be enumerated: the use of permanent moulds, "perlit" iron, centrifugal casting, die casting, malleableising, up-to-date machinery and equipment, the control of iron by chemical analysis, the addition of special elements such as nickel to cast iron, the more difficult foundry practice of certain non-ferrous materials such as aluminium and magnesium alloys, the more up-to-date knowledge of refractories, sands, oil cores, the technique of electric furnaces, etc., etc. To take advantage of and to appreciate all these it must be recognised that a scientific training for the apprentice is necessary.

The Scientific Mind.

A man may be said to have a scientific mind when (1) he thinks in an orderly manner; (2) when he makes a mistake, acknowledges it and, settling down to reason it out and finding the why and wherefor, finds a cause and sees that the mistake is never repeated; (3) is progressive and always tries to improve, step by step, and (4) is never too old to learn and benefit from the experience of others. He is not necessarily a man full of technical information. It must be pointed out that a scientific training is a development of the mind and a teaching which endeavours to bring order out of chaos and is not the mere assimilation of a multitude of theories and facts. It is also the co-ordination of the theoretical and practical. There is always mutual respect between the best type of practical man and the so-called scientific man. They realise that they are complementary. Both have the same type of mind, and there is no doubt at all that the highly-skilled craftsman has an orderly mind developed by his actual practical experience. A scientific training during apprenticeship will help to develop that orderliness of mind so essential to the successful craftsman, and his final standard will be attained earlier than relying on experience alone. It must be emphasised that the educational training is meant to be an *aid* and not a *substitution* of any of the practical work. There are in the foundry world to-day scientific men who have had little or no definite educational training.

Many years ago Faraday said that "the physics of to-day is the engineering of to-morrow," and never was it more true than it is to-day. It is necessary for practical men to be led by easy stages to realise the importance of this work. Provision should be made so that all apprentices should have a scientific training—not necessarily a technical or vocational training, which is generally a cramming of one type of information—but an easy introduction to the fundamentals, so that almost unconsciously the mind of the apprentice is developed along scientific channels. The technical information necessary is then a matter of comparative ease, being merely the application of his fundamental knowledge.

In almost every other industrial area of this country facilities are provided for the educational training of foundrymen. There is no such provision in South Wales specially adapted for foundrymen. South Wales has a great industrial future possible, owing chiefly to its geographical position, which offers many obvious advantages—easy transport by rail and sea, nearness to the central areas of the country, fuel, established industries, and large areas of land available for the establishing of works and factories. With this development is almost certain to be a corresponding increase in foundry work. It must not be forgotten that a large amount of foundry work is lost to South Wales which need not be. The prospects are good, but the quality must be assured. To enable the best to be had from our resources the training of apprentices must be broadened in this district.

The scientific training given to apprentices must be thorough and not hurried. It is best taken as a definite part of his working apprenticeship, *i.e.*, so much time per year should be given to attendance at classes. It is not right that a young man on the threshold of life—in the most critical age—after working hard all day in the foundry—should spend out of every week two or three evenings at school and then two or three evenings studying at home. The boy's strength and vitality are bound to be sapped and he becomes prematurely old. The "sandwich" system has worked very well in the training of apprentices for the engineering trade. These apprentices spend so many weeks or months every year in school and then return to the shops. This is worthy of examination in forming a training scheme for apprentices in this district.

There is no reason at all why the foundries in this district should not amalgamate, under the guidance of the local section, to control the educational training of all apprentices by forming its own foundrymen's school. One of the biggest coal concerns of South Wales has established its own school, working on most modern methods for training its own mining engineers.

Once the apprentice has reached the necessary standard by gradual but thorough training in the fundamental sciences, mathematics, chemistry and physics, the necessary technical training could be given by attendance at classes in the various branches of foundry work, given by practical men actually engaged or who have been engaged in the craft. The apprentice should also attend courses in certain cognate subjects such as machine drawing, practical and theoretical metallurgy, electrical technology, etc. If the apprentice has reached matriculation standard before commencing "his time," he could proceed direct to the "foundry classes." If he had not, then he could attend any of the classes in chemistry, physics and mathematics organised by the various local education authorities or technical schools, and after "passing out" proceed to the "foundry classes."

No attempt has been made to outline any definite training scheme, because it is thought that that is a matter for a conference between interested parties. However, the authorities of the Cardiff University College were willing and anxious to help all local trades.

DISCUSSION.

MR. MAKEMSON said that probably no part of the foundry trade had had so much attention paid to it in discussion as the training of apprentices, and still there was not a unanimous opinion on the subject. Perhaps this was due to the fact that they were not quite clear in their ideas as to what they were aiming at. First there had to be considered the moulder in the trade and then the managerial and metallurgical side of the industry, but we had to admit that the training for the one was not the same as for the other, and, again, a craftsman might be extremely useful without having any technical knowledge. Things were not going to be the same in the future as they had been in the past, and craftsmen would have to have some scientific knowledge which would give them a wider outlook.

On the other hand, there was the type one might refer to as the managerial type. Here were often seen men whose technical knowledge was very limited. In the future, managers of this type would not exist. The manager who would successfully manage a foundry would have to have a much broader training than in the past. One might aim at training both. In training the workman, one ought to aim at a training which would be broad enough to enable him to qualify for the managing class. Mr. Makemson suggested that the fundamental prin-

* A Paper read before the Wales and Monmouth Branch of the Institute of British Foundrymen. The Author is on the Metallurgical Staff of the University College, Cardiff.

ciple was to have a thoroughly good metallurgical training.

Things were not as they used to be in the foundry, and the foreman had more to do than formerly. He could not give as much time to the apprentice as he could in the old days. If the workman had to give his time to training apprentices he lost money, and, consequently, the apprentice was left to pick up information as best he could. He thought there should be a man whose job it was definitely to instruct the apprentices, and he also thought this would pay. The appointment of an instructor would mean that boys would earn profit at an earlier age, and the profit would pay the salary of the instructor. Then better workmen would be available.

With regard to a school, it would pay large employers to run their own school and small employers to join together to run a school. This would enable boys to build a foundation upon which good workmen could be built.

The Institute of British Foundrymen were giving serious attention to this problem and intend to try to establish an examination on a national basis. They were arranging with the City and Guilds of London Institute to include an examination, and there was every reason to hope that an examination in foundry practice would be established. It was also hoped that the Institute of Mechanical Engineers would create a modified form of examination of the professional standard which would carry with it a diploma of almost the degree type. By instituting these national examinations, the Institute believed it would give the apprentices something to achieve.

Local education authorities would provide classes, but the trouble was to get the boys to attend these classes. Often the teacher and equipment were waiting for the students who were lacking. But if examinations were instituted it would be an incentive to students to come forward and possibly the establishment of further classes would be justified, resulting in quite a large number of highly-trained men throughout the industry.

There was less competition in the foundry trade than in other similar trades, and, given the right type of boy who was prepared to work hard, it did offer him opportunities such as were offered by very few trades.

Compulsory Technical Education.

MR. HARRISON said he would like to see the system of apprenticeship include compulsory attendance at a technical school. Some large works had their own schools, but he did not think this would be suitable for South Wales, neither did he think it necessary on account of the institutions already available where apprentices could get a part-time course. The first three years of apprenticeship the boy should attend evening classes, but he should not be expected to start work the following morning before 9 a.m. At the term examination, if he did sufficiently well he would be recommended that the last two years should be spent six months in a shop and six months as a full-time student in a technical school.

Incentives for the Apprentice.

MR. MCCLELLAND asked, "What had these boys to look forward to? What was to be the encouragement for taking up higher education?" The number of managerships were limited, and he thought it was possible at present to turn out more educated men than necessary to fill these positions, and also those of foremen too. Mr. Harrison had suggested that America could teach us nothing in education and training. Last summer an American foundryman had stated that Britain had a very big advantage because when she trained her boys to be moulders, she made tradesmen of them, and when they went to America they could be relied upon as knowing their job. On the other hand, there are some things associated with American practice from which we could benefit. The foundries should get away from the flat-rate system of wages. When he had worked in America the system in vogue was for beginners to be paid the minimum rate, but there was a vast difference between the minimum and maximum rate. In this country the man who could make firebars and nothing else could earn as much as the man who could make anything, and this was a most unsatisfactory position. It would not be to the detriment of master or man to reconsider this and consider making some arrangement which could be applied to ambitious men.

MR. GALLETLY said the most important question was that of choosing the lad. It would astonish anyone to come to his works and see the number of fathers who brought their sons to see him without the slightest ideas as to what they wanted to do. The engineer who is going to be successful is the boy who *will* be an engineer and nothing else, and the same applies to the good moulder. Not enough advice was given to boys, and parents oftentimes neglected this part of their duty. Lads should be helped to find their bent. He was afraid we had too much education at the wrong time. If a boy was going to serve an apprenticeship he should come as soon as he was 16, and opportunity should be given him for extra study.

Moulder or Foundryman.

MR. HIRD said this subject of training of apprentices had been one of the planks of the Institute of British Foundrymen for a considerable time. In the old days, a boy was taught to be a moulder only. Now many foundries have dropped this idea, and a change had come over both equipment and method, and it is only by thrashing out this question nationally that we can get down to something which can be a national system. He thought something should be done whereby the master should get one of the men to look after the boys. Apprentices do not get all the attention they should have on account of lack of time of those in charge.

We were losing the old-type moulder, and when trade revived there would be a great outcry for real craftsmen and men for the managerial side of the work.

MR. R. G. WILLIAMS said he thought more attention should be paid to the educational side of the problem before school-leaving age was reached. The one point which seemed to be overlooked was the fact that children left school too early, and one reason why there was a shortage of apprentices was that most boys, who were forced to earn at the age of 14, chose the engineering side of the work in preference to the foundry. Mr. Jones had suggested that the foundry should aim at securing boys of the matriculation standard, and he thought this aim should be realised. First of all a good primary education was necessary before training commenced. A patternmaker should go into the foundry. This was more important than that a moulder should go into the pattern shop. Every boy should go into the machine shop.

MR. R. J. RICHARDSON thought that boys entering the foundry should undergo physical fitness and aptitude tests for the work. He would suggest that boys enter at the age of 15 and pass through every department. They should be put on all classes of work, including the sand mill, and during the time spent in the dressing shop it would be seen if the boys were physically fit to go on with the work. He thought the best method was to attend evening classes until the age of 16, when a report should be given and on this report boys should be chosen. Progress should then follow as the result of competitive examinations. The best boys would thus be encouraged in the craft.

MR. MAKEMSON said he would like to emphasise that he thought any scheme of apprenticeship should include a knowledge of drawing in preference to metallurgy for the moulder. With a moulder such knowledge was useful, but for a foreman it was essential. Many courses have a metallurgical bias, and in many cases drawing was omitted.

MR. DEWFALL suggested the boys should be given a chance to try those jobs which all knew to fall out in the middle when made. The boys should have an opportunity to try such moulds before they were called upon to make such a job commercially. The apprentice was always in fear of making a waster, and he should have had the opportunity afforded him when training of trying all the known snags.

Government System.

MR. WALL said the best system he had encountered was that adopted in the Royal Dockyards, where an apprentice serves from the age of 15 until he is 21. He does half-time in the special school and half-time in the foundry, in which a skilled workman is paid a few shillings a week extra for the care he takes of the boy. At the age of 21 one has a polished craftsman. If an apprentice served under a man who is working piecework, the more efficient apprentice was making a profit for the man. The office paid the boy and the boy was making the more profit for the man.

MR. KINSMAN said we were up against prices, and the only way some of the works could take apprentices was to put them on one job. Otherwise they would not be able to run their businesses.

MR. W. R. D. JONES said he did not want this matter to be left alone now. He wanted the Branch Council to worry out a scheme, or the whole evening would have been wasted. They must ascertain if South Wales could not get better boys into the trade, as there was bound to be an industrial future for the district.

Mr. Jones thought that the man who was made manager should have been a foreman first. He would like to ask whether Mr. Makemson considered a foundryman should have more training in mechanical engineering than metallurgy? Germany had come to the conclusion that a foundryman should know more of metallurgy than engineering. He also thought attendance at classes must be compulsory, although he would agree to a boy having a preliminary training before signing indentures. He wanted to make it quite clear that a boy should not be a boy labourer. When parents had to pay for education they saw their children got it. Free education is very useful, but there seemed a tendency to carry this a little too far. Boys have not been made to work. The speaker and Mr. Harrison had talked over this matter very seriously, and there was much in what Mr. McClelland had said. The industry should pay for skill. Mr. Hird had suggested one man should look after the apprentices, but it was not agreed that this would be a good thing, and not many foundries in South Wales would be able to afford to do this. All must get together and amalgamate from a technical-education point of view. The three essentials must be taught—physics, mathematics and chemistry. Mr. Richardson's scheme sounded very good, but it required expert investigation before anything like it could be adopted. The evolution of a scheme depends upon the interested parties bringing out an elastic scheme. Evening classes were all very well. The boy went to a technical college for two or three hours and was then given home work. This taxed the strength of the boy too much. Most metallurgical students have to attend classes of machine drawing and to know the strength of materials.

MR. MAKEMSON, in response to Mr. Jones, said that the men employed in such foundries as Citroën and Morris would have to have more engineering knowledge than anything else. On the other hand, where varying types of metal are made, a man would have to have more metallurgical knowledge than anything else. He would say that metallurgy came first, with a certain amount of engineering knowledge added.

The Moulding of Large-Size Marine Steam Cylinders.

POSSIBILITIES OF EXPEDITING PRODUCTION AND REDUCING COSTS.*

By Thomas Davis.

The moulding of large-size marine cylinders is a specialised class of foundry practice. It is, moreover, a difficult proposition, calling for the highest degree of skill on the part of the moulder. The methods adopted in the various foundries vary according to shop facilities. For instance, the capacity and number of cranes will probably determine whether boxes or pits have to be used. The actual moulding may be said to be restricted to either loam or dry sand. As the Paper deals with large-size cylinders, it will be admitted that loam is the method most generally used. It is proposed, therefore, to take as an example a large marine steam

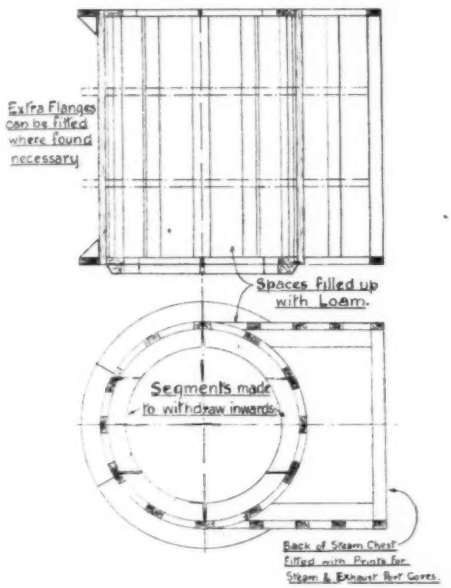
Extra Flanges can be fitted where found necessary
Spaces filled up with Loam.
Segments made to withdraw inwards
Back of Steam Chest fitted with Points for Steam & Exhaust Port Cores.

FIG. 1.—SUGGESTION (NOT DRAWN TO SCALE) OF PROPOSED ARRANGEMENT OF SKELETON PATTERN FOR CYLINDER.

cylinder, weighing six tons, made in loam, built and cast in a pit.

The Pit.

The pit for such a mould is generally in the form of a large square box sunk in the floor. It can be made by casting four open-sand plates and bolting them together. Preparation is made for securing the top part when the mould is cast, by making a strong cast-iron plate in which are cast four or six large lifting irons. When the mould is ready for casting, beams are arranged across the top part, extending over the lifting irons, and made secure to them. The plate is bedded below the pit floor, and the lifting irons are arranged so as to fit close up to the sides of the box. The lifting irons should not extend above the foundry floor. The pattern for such a casting is generally made on the skeleton type and collapsible, the spaces between the spars being filled in with loam during the process of—or previous to—the actual moulding. Such a pattern is shown at Fig. 1.

The Moulding.

A bed is first swept out to receive the pattern, the centre core print of which fits into the recess round the spindle, as shown in Fig. 2. The distance from the top of the pit to this bed will be the depth of the pattern. When the pattern has been set to the desired position, the building-up process can be commenced. Assuming the spaces betwen the spars of the skeleton pattern are to be built in periodically, and not at one operation, the moulder now fills in these spaces to the depth of, say, 2 ft.; thereafter this is dressed off and a joint made all round the pattern. The process of building-up the mould can now be commenced. The flange is usually broad at the bottom, and it is the practice in some shops to "build up" to the face of this and make a joint all round the flange, draw it, and cover the spaces with strong loam cores which have previously been made from a core box of the correct curve to fit close up to the pattern.

The other method is to leave the flange in until the pattern is stripped; it can then be drawn into the mould. If the latter method is adopted care should be taken to see that all screws and nails are removed, so that the pattern can be stripped without disturbing the flange. The building-up process can then be continued. Sometimes short branches with their

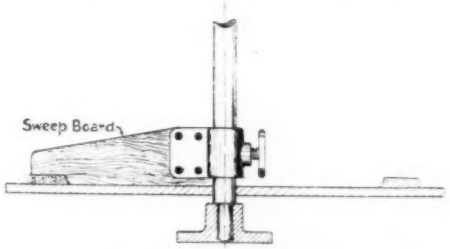

FIG. 2.—SWEEP BOARD.

flanges are placed on the outside of the steam chest, and the methods in dealing with these and similar projections are varied. One method is to make a joint round the flange, draw it, finish and blackwash the recess, and cover the space with a loam core, in the centre of which is a hole the same diameter as the print on the branch. The branch can afterwards be drawn into the mould. In this case the sand between the flange and the face of the mould requires strengthening with iron to resist metal pressure.

Another method is to pack all round the branch with black sand until level with the top of the flange, then continue moulding as usual. When the pattern has been stripped, the sand round the branch can be scraped out and a joint made rather wider than the flange. This can be continued on the lines of a small draw back, using a cast-iron ring with prods to support the loam or sand to be used. In moulding cylinders of this dimension the port and exhaust cores are of considerable size, and special provision must be made for fixing and holding them in their respective positions. This is done by fixing plates at the back of the chest. These plates have holes in them to receive the bolts cast in the exhaust and port core irons, as will be seen later when assembling the mould. After the mould has been built-up to the height of the first section in the skeleton pattern, another section is filled in between the spars similar to the first. This process is continued until the mould has been built up to the top. The top of the moulded cylinder will be the bottom of the cylinder when in working position in the ship, consequently it will have branches with their flanges to rest upon columns. The steamway may stand 4 or 5 in. above the level of the mould, the flanges above the faces the same, and probably a few round bosses. The usual practice is to make light cast irons to go all round the intersecting parts already referred to, care being taken to see the irons do not interfere with the drop runners. The irons are claywatered and bedded on an inch of loam sand and the runners put in position and rammed up to the top of the flanges and a joint made over the whole, including the outside joint. A good, strong top-part covers the whole job, and is rammed up, plugs being placed on the top of the lifters or hook-bolts cast in the core irons. The box is staked at the corners and lifted off, the flanges are drawn and the recesses finished and blackwashed, and the same with that part of the top part which covers them. The box is then put on again, the irons secured to the top part, which, when lifted off the second time, brings the core irons and false joint with it. The top part is then turned over, finished and blackwashed in the usual way. The skeleton pattern is then stripped, and the moulder can finish the mould from the inside.

Core Desiderata.

A very important part connected with cylinder work is the cores, particularly the port core. Without good sound cores one cannot produce good cylinder castings.

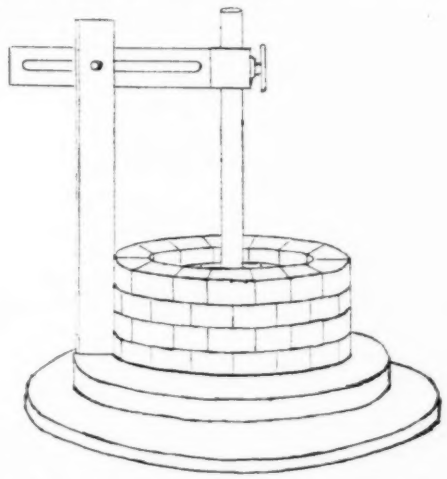

FIG. 3.—STRIKING-BOARD FOR SMOOTHING LOAM LAYER OF THE BODY CORE.

Centre Body Core.—The body core of a large cylinder is generally built up with brickwork and covered with a layer of loam, which is smoothed with a striking-board rotating on an arm fixed to a spindle, as shown in Fig. 3. This core is sometimes strengthened by using core irons (Fig. 4) about 4 in. less in diameter than the size of the core. These are bedded in the loam and brickwork, the distance between each iron being about 18 in. Special care must be exercised in making this core, as it forms the bore of the cylinder, and the casting here must be perfectly free from any such defects as scabs or blow holes. A good method of venting this core is to use a good size plug in the centre, drawing this out periodically and filling the space with coke. Fine coke can also be used to carry the vents through the loam and brickwork into the main centre vent.

The Port Cores.—The port cores are also made in various ways. Some firms rely upon loam, others prefer good strong core sand, with a liberal supply of sharp sand to assist in venting, while, again, some firms have evolved mixings which, for perhaps quite legitimate reasons, are best known to themselves. Whatever material is used for these cores, it should be such as will give a good firm core, with the maximum of porosity, and leave the casting with freedom. The core iron is usually made to fit the curve of the box, thus helping to give strength and

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* This Paper was awarded a prize under the Surtees Memorial Scheme.

rigidity to the core. The method of venting a port core is one of the most important items in connection with cylinder castings, whether marine or otherwise, and too much stress cannot be placed on this fact. Wax vents are extensively used for these cores, as they can be turned in any desired position, and when the core is dry they leave a perfectly clear vent. The curve on the port, which fits up to the large centre core, is left $\frac{3}{4}$ in. short to allow a clearance when the centre core is lowered into position.

The Exhaust Core.—The exhaust core does not present the same difficulty as the ports. Its essentials are that it should be a good strong core, well vented with coke; one that will stand rough usage, and not crack when screwed into position. Such a core will meet the requirements here.

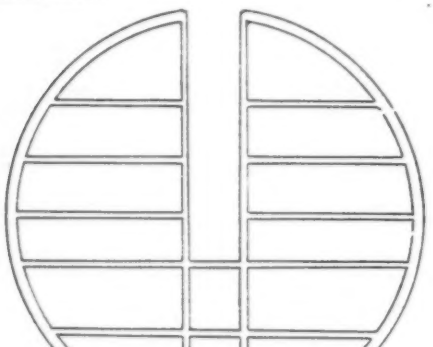

FIG. 4.—CORE IRON FOR STRENGTHENING THE BODY CORE.

Assembling.

When the mould is dry, and the cores all ready, the task of assembling begins. The small branch cores—if any—are first put in their correct positions and made secure. The bottom port core is next lowered into the mould, thickness pieces being placed so as to give the required metal. If the core is carefully managed it can be gradually forced into position in the core seat in the chest. The bolts cast in the core iron and protruding from the core, pass through the holes in the plate at the back of the steam chest. The port core can now be made secure. The thickness pieces can be left in meantime, and others placed on the top of the port core to receive the exhaust core. This is now lowered to position, as in the case of the first port core. Thickness pieces are then placed on the top of the exhaust core to receive the top port core, which in turn is placed in position similar to the bottom port core, with this difference, that whereas the top core takes the upward curve, the bottom core takes the downward. When the exhaust and port cores have been screwed firm to the chest plate, the thickness pieces—which should be well tapered—can be taken out. A square should now be tried all round the core seat of the large centre core to see if the port cores show a clearance (Fig. 1).

The large centre core is next lowered into position. Care should be exercised with this core, otherwise much damage will result. When the large centre core has been placed in correct position, preparations are made for a "try on" with the top part. The spaces all round the cores are packed with waste as a precautionary measure to prevent any sand from getting to the bottom of the mould, which might drop off the top part. The top part is then tried on, and a little powdered chalk is dropped through the runners to see if they are in correct position. If everything seems satisfactory, the waste is removed and the top part replaced. The runner and riser heads are made up, and all vents attended to. The pit is filled up, and the top part securely bolted down, and the mould is then ready for casting.

The object of this Paper is twofold. First, to give a general outline of the moulding operations of a large-size marine cylinder, and secondly, to suggest alternative methods with a view to expediting production, and reducing costs. The first part having been accomplished, the second part can now be attempted.

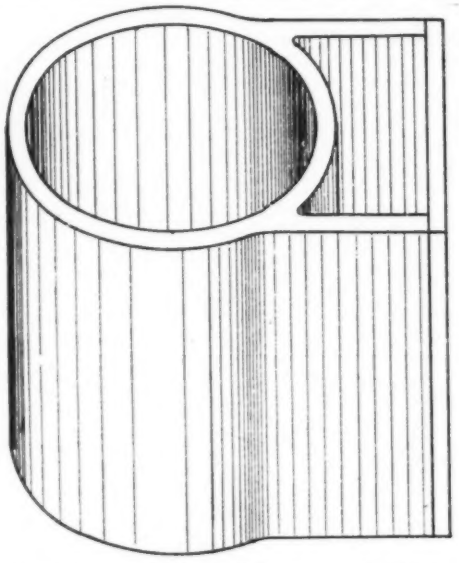

FIG. 5.—ALTERNATIVE PATTERN CONSTRUCTED LARGELY OF LOAM.

In this respect the first item of consideration might be directed to the pattern. It cannot be denied that, whenever a pattern has to be constructed, no matter how simple, it is a matter of considerable time and expense. As an alternative method to the skeleton pattern, it is possible to construct a pattern almost entirely of loam. Such a pattern is seen at Fig. 5. The first part of the pattern is made by "sweeping up" a core the size of the outside diameter of the casting. This need not be solid, but a thin shell will suffice. The sides of the chest are easily built up straight, and the back of the steam chest can be made of wood, and to which the core prints of the ports and exhaust can be fixed. The flanges are, of course, made loose, and branches, strengthening ribs, or bosses, can quite easily be fixed. If the branches and bosses on the top of the cylinder are difficult to fix, these can be screwed to a frame and secured to the loam work.

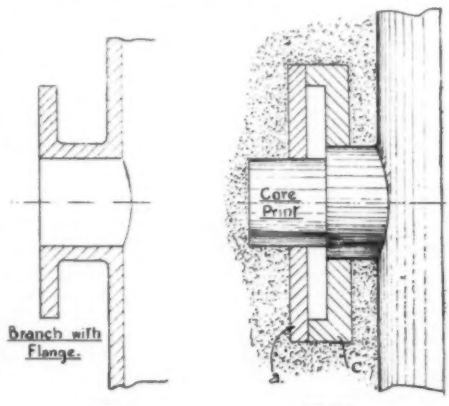

FIG. 6.—SMALL MOULD APPLIED TO A BRANCH.

Another alternative method can be applied to the moulding of the cylinder top. In the first part of this Paper it was explained how the core irons were bedded on a bed of sand and rammed up to the top of the flange faces, and a false joint made. A much better and quicker method can be applied by a simple re-arrangement with the flanges. First take each flange and make a mould off it in a strong loam core, as follows:—Place the flange on a board, put a frame over it, say 3 in. deep, and allowing an inch and a-half bearance all round. In the centre of the flange put a plug, the same diameter as the branch to which the flange is connected. Make a good strong core. Draw out the plug, put a plate on and turn it over. Draw out the flange, remove the frame, and the "mould" is finished. Make another flat core the size of the "mould." When the "mould" is dried it is applied as follows: When the irons have been bedded on the top of the pattern and partly rammed up, the small mould is placed on the branch, the hole in the centre will allow it to be set to the correct height. The flange is put in the mould in order to show correct position. When the sand has been made firm under the "mould" the flange is taken out and covered with the flat core. One now sees the flange made secure in a small dry mould. When all the flanges have been treated thus, the top part can be put on without making a false joint. The top can thus be rammed-up and lifted-off at one operation. Fig. 6 shows the small mould applied to a branch. By an extension of this principle—that is, by carrying the mould to the bottom of the branch—the use of core irons could be eliminated.

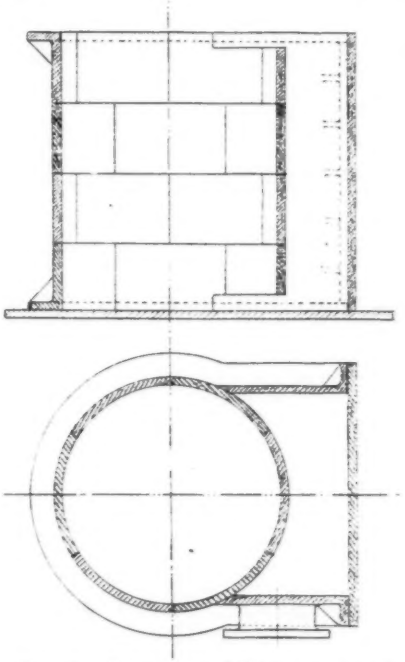

FIG. 7.—A SUGGESTED MOULD BUILT UP WITH LOAM SEGMENTS.

This method can be applied to any branch having a flange attached to it. Should the branch happen to have a print, then the flat

(*Continued on page* 440.)

The Correlation of Mechanical Tests for Cast Iron.*

By J. G. Pearce, M.Sc.

[BRITISH EXCHANGE PAPER.]

(*Continued from page* 416.)

Change of Strength with Section.

The nature of the change of strength with section is illustrated in Figs. 7 and 8, where curves 7A and 8A represent the transverse strengths of two irons of analyses given in Table I for bar diameters of 2.2 in., 1.75 in., 1.2 in. and 0.875 in. Half the transverse strength in lbs. per sq. in. is plotted against diameter, and it is clear that transverse strength increases with diminishing diameter. Fig. 9 shows a similar curve drawn smoothly through the points, for a series of eleven bars from the same ladle varying in diameter from 0.5 in. to nearly 5 in. Curve 9A represents the curve obtained on the bars as cast and curve 9B on similar bars skin-machined, which are higher by some 5 per cent. The amount removed in each case was about 0.05 in. The span in this series of tests was 21 in.

The slope of the curve is determined by many factors in the melting conditions apart from composition, and while these curves are of similar type the multitude of factors affecting the issue renders it unlikely that the change is represented by any simple physical law. There seems little point, therefore, in plotting the results on a logarithmic basis.[9] A number of such curves have been so treated without yielding a simple physical law. In some irons the size-strength curve is almost straight and vertical, the heavy sections being nearly as strong specifically as the lighter sections, while in other cases the specific strength of thicker sections falls off sharply.

Size-strength curves may be prepared for a given set of melting conditions (*i.e.*, in any one foundry) for various compositions, particularly silicon contents. As would be expected, the low silicon irons, being strongest, are on the extreme right of the chart, and intermediate and high-silicon irons are more or less parallel and further to the left as the silicon increases. Fig. 10 shows a chart for three mixtures of remelted pig-iron from one foundry, analyses being given in Table I.

It will be obvious that the establishment of a continuous variation of strength with section provides the basic justification for specifying a test-bar for a given casting approximating to the thickness of the casting.

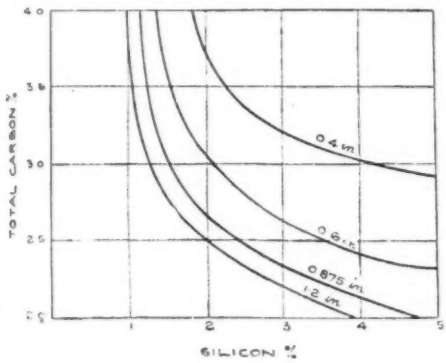

FIG. 5.

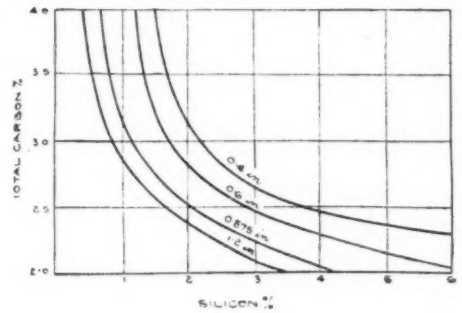

FIG. 6.

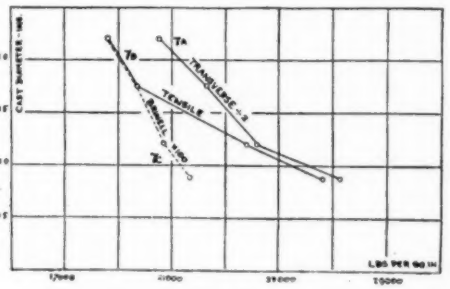

FIG. 7.

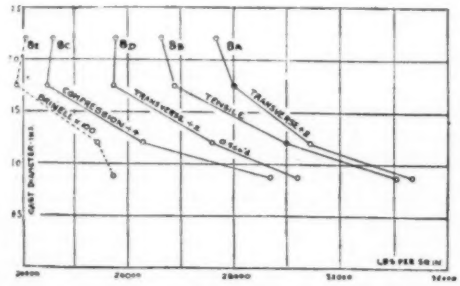

FIG. 8.

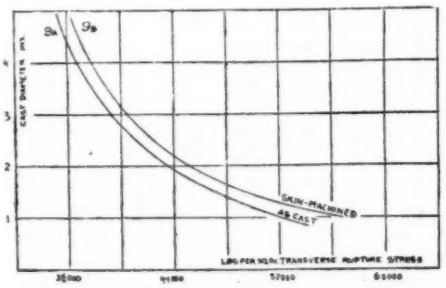

FIG. 9.

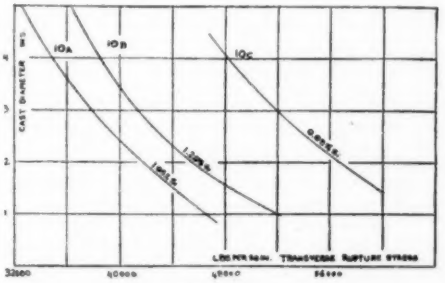

FIG. 10.

FIG. 5.—Ferrite — fine-graphite irons. Lines separating grey from white and mottled irons in sand-cast bars of stated diameters and compositions.

FIG. 6.—Pearlite — normal-graphite irons. Lines separating grey from white and mottled irons in sand-cast bars of stated diameters and compositions.

FIG. 7.—Variation of transverse and tensile strengths and Brinell hardness with diameter of cast bar for skin-machined bars.

FIG. 8.—Variation of transverse, tensile and compressive strengths and Brinell hardness with diameter of cast bar for skin-machined bars (A, B) and bars machined to 0.564 in. dia. (C, D).

FIG. 9.—Variation of transverse strength with diameter of cast and skin-machined bars.

FIG. 10.—Variation of transverse strength with cast diameter for mixtures of remelted pig irons.

It may be noted that the diameter d chosen as an index to rate of cooling is reciprocally proportional, if in a long bar the influence of the ends be ignored, to the ratio $\frac{\text{area}}{\text{volume}}$ recommended by Bolton,[10] which in a cylindrical bar is $\frac{4}{d}$. The author has not, however, found this ratio satisfactory for complicated shapes.

The change of strength with section for a given range of sections is a maximum for separately-cast bars. In a casting of varying sections the thin parts will gain heat from thicker parts and cool more slowly and *vice versa* for thick parts. Hence, while results on bars do not apply to the actual castings, they may be regarded as furnishing the extreme case, and by experiment a size of test-bar may be chosen in excess of the dominating section of the casting which will give strengths similar to that of the casting.

The tests mentioned above have been carried out on a strictly standardised basis, for the transverse rupture stress varies not only with size, but also with shape. The B.C.I.R.A. has shown, for instance, that a square bar is, area for area, weaker than a round bar, and that the result is not due to a casting effect, but to a testing effect, for the difference between round and square bars, when tested as cast, persisted when round bars were tested after machining from the square and square bars after machining from the round.[11]

The stress distribution during the test doubtless differs markedly from the theoretical in each case, and the differences are not parallel as between the two shapes. The author has also confirmed the observations of Mathews[12] that transverse rupture stress diminishes as span increases.[13] Hence it is necessary to add to the previous conclusions the requirement that strength of cast-iron bars examined by the transverse test must be determined on standard bars tested by standardised procedures.

By treating transverse results on this basis it is practicable to show the continuous nature of change of strength with section from results in many Papers, as far back as those published in 1837.[14] [15] Particular interest also attaches to early American studies of this question,[16] [17] published by the American Society of Mechanical Engineers and the American Foundrymen's Association.

Change of Strength with Composition.

It is evident from Fig. 10 that strength changes with silicon content as well as with size, and in Fig. 11 the transverse strength is plotted against silicon content for each of the three mixtures illustrated in Fig. 10. As might be anticipated, there is an increase of strength as silicon content diminishes. Similar curves derived from results published by Rother and Mazurie[18] are practically parallel straight lines.[8] Such a group of curves should be of great value to any foundry determining them

for its own mixtures, as silicon is the usual basis of control. They enable the strength obtainable in a given size of bar to be predicted for a given silicon content and *vice versa*. They should be of value to designers, and they permit the influence of changes in the melting programme, such as the use of steel additions, to be readily determined.

It is occasionally suggested that it is useless labour to obtain a range of test-bars in varying diameters and of one composition for the purpose of charting a size-strength curve, since commercially only one thickness or narrow range of thicknesses is suited to a particular silicon content. There is, however, considerable doubt as to the precise limits of silicon content for a given thickness, even when confusion due to the effect of mass, variations in other constituents and in melting conditions is avoided, on account of the varying margins used in the industry against hard spots and mottling, or to the relative degree of inconvenience of these troubles. The temptation to use one mixture for a variety of castings in jobbing practice also obscures the relationship. The establishment of size-strength and size-composition curves may, therefore, be regarded as the first step towards a knowledge of the precise composition required to produce a given strength. The latter curves give the thickness at which the strength is a maximum for a given composition, and to this basis safety margins can be rationally added. Naturally it is not necessary to have the full range of diameters for every silicon content.

When the iron changes from grey to mottled or white the size-strength curves frequently bend sharply and strength begins to diminish as size diminishes. There are thus two diameters of the same strength, one harder and one softer than the maximum. White iron often proves stronger than grey, but its brittleness prevents an accurate idea of this being obtained. The strength of white iron is very erratic.

Effect of Varying Melting Conditions.

The effect of variation in conditions of melting may be illustrated by the scatter in Figs. 12 and 13, in which a number of results are recorded. A score of foundries, members of the British Cast Iron Research Association, were asked to cast bars from a cupola-melted mixture made in the ordinary way of business and suitable for engine practice, either ordinary cylinder or turbine quality or the still better quality required for Diesel engines. Each mixture was represented by four bars, 0.875 in., 1.2 in., 1.75 in. and 2.2 in. in dia., three of these being standard British bars, as indicated below. In Fig. 12 silicon content is plotted against transverse strength of 0.875-in. bars expressed as a specific stress in the way suggested above. In Fig. 13 the same figures are given for the 1.2-in. bar, represented by closed rings. The double rings show results on alloy cast irons containing nickel, tested under the same conditions. Much work on alloy cast irons has been carried out recently in Great Britain with very promising results, as these figures indicate. The bars charted contained about 1 per cent. nickel.

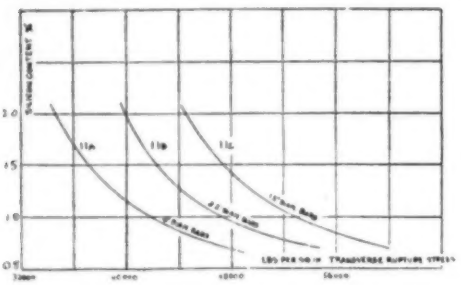

Fig. 11.

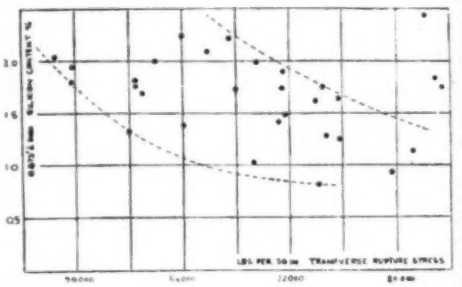

Fig. 12.

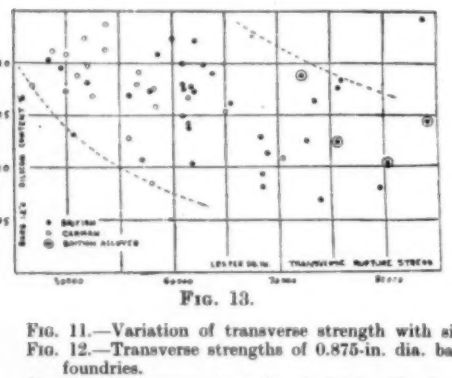

Fig. 13.

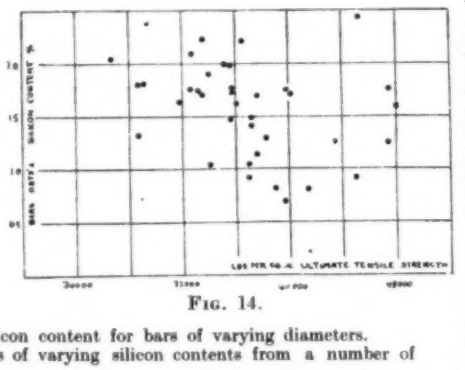

Fig. 14.

Fig. 11.—Variation of transverse strength with silicon content for bars of varying diameters.
Fig. 12.—Transverse strengths of 0.875-in. dia. bars of varying silicon contents from a number of foundries.
Fig. 13.—Transverse strengths of 1.2-in. dia. bars of varying silicon contents from a number of foundries.
Fig. 14.—Tensile strengths of 0.875-in. dia. bars of varying silicon contents from a number of foundries.

The open rings refer to a series of melts recently made in Germany for the purpose of ascertaining how far a group of foundries could meet a given specification (21.5 tons per sq. in. transverse), with their own charges and with specified charges.[19] The scatter is shown to be equally pronounced. Dotted lines in Figs. 12 and 13 show the approximate limits of strength obtained from irons of the same silicon content; the range is nearly 30 per cent. on the mean for the 1.2-in. bars and somewhat less for 0.875-in. bars. Each set of bars, however, in the British tests showed consistent results among themselves with regard to change of strength over the range of sections cast, as shown by Figs. 7 and 8, which represent two of these mixtures. Furthermore, where more than one mixture came from the same foundry with the same melting conditions, the change of strength with silicon content was similar to that shown in Fig. 10. Where the melting conditions had been altered, as by the use of a steel charge, this relationship did not hold. Fig. 16 will serve to illustrate this, for all four mixtures there represented were poured in one foundry and the strongest iron, A, had a silicon content almost as high as any other iron in the group. B, C, D followed in this order of increasing silicon, as would normally be expected from the strengths shown. The relative analyses are given in Table I.

In view of tendency to the wider use of the tensile test, Fig. 14 gives the tensile strength taken on the 0.875-in. bar, plotted against silicon content, for the same British series as in Fig. 12, with a few other available figures. The definition of an iron mechanically by a combined transverse and tensile test suggests that it may conveniently be indicated in relation to other irons by using the two strengths as co-ordinates. This is done in Fig. 15. As in Fig. 13, closed rings refer to British series with a few other available results. Double rings are alloy irons and open rings German irons.[19]

On this chart specified transverse and tensile tests for a given iron can be defined by a point which is the origin of an upper right-hand quadrant. Any iron tested falling in this quadrant pass the specification. Thus closed squares marked C and A define the mechanical properties of the Grades C and A of the British national specification 321/1928.[20] Similarly, open squares P, Q, R, S refer to four specifications recently adopted in Germany,[21] while double squares W, X, Y, Z refer to the U.S.A. specifications[22] for ordinary grades and high-test iron.

It will be obvious that, in spite of a considerable measure of scatter, there is an approximate relation between transverse and tensile tests. That part of the curve drawn as a straight line broadly averaging the British and German figures, gives for tensile strength in lbs./sq. in. (T) and transverse strength in lbs./sq. in. (R) the equation $T = 0.59R - 4{,}000$. Any pair of values gives the approximate ratio $\frac{R}{T}$ as 1.86. For a given tensile strength the British specified transverse values lie between the German, which are the lowest, and the American, which are highest. The ratio of R to T is not constant. It diminishes for high-quality and increases for lower-quality irons, as the range of tensile strengths is wider than the range of transverse strengths. This variation would be expected on theoretical grounds.

Deflection in Transverse.

The deflection figure on transverse yields much important information, and the deflection figures for all the transverse tests obtained in this Paper have been obtained; in many bars the deflection has been taken at intervals in the loading in connection with the study of the elasticity of cast iron, since the breaking deflection is only partly elastic, the remainder being plastic, although the major part, some 80 to 90 per cent. of the deflection, is elastic. This question, however, is so comprehensive that it is thought best to reserve its treatment for a separate Paper. Although engineering design is based on elastic phenomena, the engineer does not at present concern himself with elastic properties as far as cast iron is concerned.

Tensile Strength.

The engineer prefers the tensile test to any other, and with good reason. There is a vast body of accumulated experience in works on the technique of tensile testing, and it is personal experience that for cast iron the tensile test, properly conducted, is sensitive, consistent and reliable. Regular changes with composition for similar melting conditions and duplicate test results repeatedly confirm this. Care must be taken that the pull is axial, and in this connection it is advantageous to have the test-pieces, which require no parallel piece for gauge lengths, tapering to the centre where the fracture takes place. A parallel gauge length is neither necessary nor desirable. In this respect the standard American test appears preferable to the British test, with its gauge length of 2 in.

The tensile test behaves similarly to the transverse in that skin-machined bars have a higher strength than bars pulled as cast, although the

essential difference in testing procedure makes a comparison difficult. When stock is removed beyond that amount which gives optimum strength, the tensile strength diminished, as shown in Fig. 16, which is on a series of 1.2-in. bars cast in four mixtures. The higher the quality of the iron, the less important becomes the amount machined off, as shown by A and B. Machining economy, however, suggests that the amount machined off should be a minimum, and in the case of the 1.2-in. bar, the test results given in Fig. 16 suggest that the reduction should be no more than the grip conditions demand. Tensile tests show the same relation between strength and size as transverse tests, and Fig. 7B and Fig. 8B show tensile results on the same irons as illustrated in 7A and 8A respectively.

Compressive Strength.

The compression strength of cast iron, seldom taken nowadays as a routine test, shows the same variation with cast diameter as tensile and transverse. The compression curves for iron 8A is shown at 8C at one-fourth the tensile scale on bars 0.564 in. dia. The half and fourth parts taken for transverse and compression do not imply that $\frac{R}{T} = 2$ and $\frac{C}{T} = 4$ are the best ratios for these tests. Some degree of separation between the curves is desirable to avoid confusion to the eye. The appearance of the compression curve to the left of the tensile and transverse curves is commented on below.

Recent Specifications.

Since both transverse and tensile tests have been embodied in the specification issued by the British Engineering Standards Association (B.E.S.A.) in 1928,[40] a consideration of this specification is in place here. The earliest cast-iron test-bars used in Great Britain were 1 in. square (tested at 36-in. or 60-in. centres), but later the rectangular bar was adopted, and the two bars hitherto used in the main have been the 1-in. square tested at 12-in. centres and the 2-in. by 1-in. tested upright at 36-in. centres. Both have been embodied in earlier B.E.S.A. specifications for particular types of castings. The new specification makes some radical departures in testing, and, although the actual qualities of metal covered are only two in number, the testing provisions can be utilised for any size or type of casting. The main features are:

(1) No chemical analysis is specified, the manufacturer being left to obtain the required mechanical properties by any mixture he chooses. This confirms the principle previously accepted in Great Britain that the quality of cast iron for engineering purposes can be defined by mechanical tests.

(2) The principle of a separately-cast test-bar is embodied in a British specification for the first time, although the purchaser still has the option of specifying cast-on bars if the design and method of running permit.

(3) Both transverse and tensile tests are specified, although the purchaser may be satisfied by either alone if he so prefers.

(4) The cylindrical test-bar is adopted for the first time in a British national specification, this rendering the square and rectangular bars obsolescent.

(5) The important principle is adopted for the first time of specifying a size of test-bar carrying with size of the casting. Three sizes are in fact provided as a first step, the 1.2-in. bar, chosen because it has already received a measure of sanction as an international bar (New York, 1913), representing castings between ¾-in. and 2-in. main thickness. Below 0.75-in. main thickness the 0.875-in. bar is specified, and above 2 in. the 2.2-in. bar is specified.

The 0.875-in. transverse bar is cast 15 in. long and tested at 12-in. centres, and for tensile reduced to 0.564 in. dia. The 1.2-in. bar is cast at 21-in. and tested at 18-in. centres, and for tensile reduced to 0.798 in. The 2.2-in. bar is cast at 21-in. and tested at 18-in. centres, and for tensile reduced to 1.785 in. dia. The whole of the tests in the Paper, unless otherwise specified, are carried out in accordance with this specification.

For other tests, in transverse testing a range of diameters, it was found desirable to standardise the span at 21 in., as in Figs. 9 and 10. The compression tests were carried out on cylinders 0.564 in. dia. and 1.128 in. long.

British metallurgists have noted with interest recent changes in A.S.T.M. specifications, and in particular the changes in the A.S.T.M. arbitration bar. In adopting the cylindrical bar, the U.S.A. was ahead of Great Britain, but the single-size bar does little more than represent the metal in the casting. To secure a closer relationship between bar and casting, instead of varying the thickness of the bar to suit the casting, the principle has been adopted of varying the load and retaining the same size of bar. It is feared that this procedure, ingenious as an attempt to retain the single standard bar, does not wholly dispose of the difficulty, for many large castings would have a composition which would, in a 1.2-in. bar, run mottled or white, be relatively weaker than tests taken on the same bars at their cast or skin-machined diameters. If a test taken on a series of diameters (skin-machined) be represented by a curve A in Fig. 18 and the same test be taken on the same series machined to the smallest diameter d, the change in strength series would be represented by a curve B, the difference depending on factors of composition and melting conditions. A curve C might represent all bars machined to a diameter D larger than d. While, therefore, the assumption tacitly made in many Papers that tests may be made indiscriminately on any size of bar that suits the testing machine, irrespective of its relation to the cast diameter, is erroneous, the strength of a machined bar is determined by its strength in the cast state. Short portions of curves such as A and B may at present, without serious error, be regarded as parallel.

In Fig. 8 the marked movement of the compression curve to the left is explained by the fact that each test was made on a 0.564-in. dia. bar. Had it been practicable to test each bar diameter in compression without more than skin machining, it would doubtless have appeared adjacent to the tensile and transverse

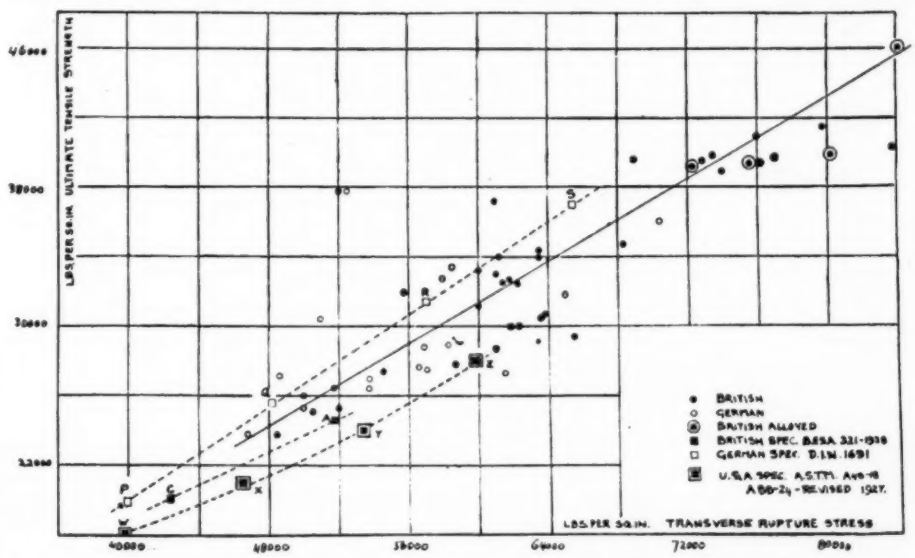
LBS PER SQ IN. ULTIMATE TENSILE STRENGTH
LBS PER SQ IN. TRANSVERSE RUPTURE STRESS
BRITISH
GERMAN
BRITISH ALLOYED
BRITISH SPEC. B.E.S.A. 321-1928
GERMAN SPEC. D.I.N. 1691
U.S.A. SPEC. A.S.T.M. A48-18 A 48-24 - REVISED 1927.

FIG. 15.—Transverse and tensile strengths of 1.2-in. dia. bars from a number of foundries, with recent specified figures.

and several recent Papers by authorities in America have expressed approval of the idea of relating the size of the bar to the thickness of the casting.

Small Test-Bars from Heavy Sections.

Returning to the question of heavy machining, it has been shown that strength in the cast-bar continuously increases as section diminishes. For some tests, compression, repeated impact, fatigue, it is imperative to machine a bar for testing whatever its cast diameter, to a small diameter of the order of half an inch. What is the effect on the test results? A set of transverse bars similar to composition to the series illustrated in Fig. 9 was tested by machining to 0.8 in. dia. throughout, and these were also tested in tensile and compression at 0.564 in. dia. The actual strengths obtained are plotted against the original cast diameter in Fig. 17A. It will be seen that the increase in strength with diminishing section is equally marked. Taking into consideration the change in the scale, it will be noted that a smooth curve through the points in A would be of the same character as, but to the left of the similar curve on the cast or skin-machined diameters, shown in Fig. 9. This weakness occurred in spite of the reduced span of 10 in. Thus tests taken on small bars machined from larger diameters will curves A and B. The partial machining essential on tensile bars also explains that B is to the left of A in 7 and 8. Furthermore, in 8, D represents a series of transverse tests on bars represented in A machined to 0.564 in. dia., tested at 7-in. centres. In spite of the shorter span there is a distinct fall throughout in transverse strength.

Returning to Fig. 17, the transverse size-strength curve is not shown as a smooth curve because for some reason at present obscure, but probably connected with an unintended change in melting conditions, the 3.7-in. dia. bar showed an increase in strength over the 3.2-in. bar. It was thought that if compression and tensile tests measured the same, fundamental property as the transverse test, the compression and tensile values would show the same discontinuity. The tensile curve is shown at B and the compression curve at C. As before, a tensile scale is adopted, and the transverse results (R) plotted at one-half and compression results (C) at one-fourth their true values. The mean value for $\frac{R}{T}$ is, in fact, nearly 2, and $\frac{C}{T}$ nearly 3.75. Thus Fig. 1 shows that when tested at the same diameter tensile, compression and transverse results maintain a constant ratio to each other, and furthermore, that tensile, compression and transverse tests measure the same basic

property of cast iron. Hence we may look forward, as time goes on, to one of these tests being standardised and the others deduced from it.

If a set of bars of the same cast diameter be progressively reduced, all tests show a regular falling-off in strength, as might be anticipated. A number of bars of the same metal and of the same diameter, tested as cast in transverse, did not vary more than ± 3 per cent. from the mean.

Repeated Impact Test.

The development of high-quality irons has created a need for a test which will discriminate between ordinary and special irons with greater sensitiveness than ordinary static tests. The transverse test is, perhaps, least satisfactory in this respect and tensile is better. Shock tests appear to have possibilities, but single-blow tests, particularly those involving a notch, have not been found really satisfactory, while the time taken to conduct a fatigue test rules it out at present as a routine test, although some promising rapid methods are being developed. A convenient test, which falls intermediately between these two types of test, is a repeated impact test, and in the form used by the Cast Iron Research Association the machine delivers about 80 blows per min. on to a standard Stanton test-piece (a ⅝-in. round bar machined to 15 mm., with a round notch 3 mm. wide and 1 mm. deep) rotated through 180 deg. between the blows. The number of blows to fracture is recorded. By suitable adjustment several combinations of falling weight and drop can be used, and the B.C.I.R.A. standard has as energy impact of 0.48 ft.-lbs. (4.8 lbs. falling through 1.2 in.). The test is used on a purely empirical basis, and it is found that the impact value rises with diminishing silicon and phosphorus, diminishing graphite content and diminishing size of graphite.

An ordinary cylinder iron withstands 200 to 300 blows, while a special engineering iron may withstand 800 to 1,000. In Europe the standard blow adopted is smaller, which gives, of course, a much greater number of blows before fracture. The use of two standards creates some difficulty in transposing, but when it is considered that some experimental irons made by the B.C.I.R.A. have withstood nearly 100,000 blows, taking two to three working days to test, the inadvisability of a softer blow is obvious.

An approximate transposition might be effected by the use of a curve such as Fig. 19, which shows the results of a series of bars tested at each of the six combinations of weight and drop available. It is not known whether curves for other irons would be similar.

Brinell Hardness.

Brinell hardness, if conducted with the 10-mm. ball, gives useful comparative data, but the Brinell hardness does not appear to fall in the larger sections or rise in smaller sections as much as tensile or transverse strength. The slope of the Brinell curve is greater. The Brinell hardness for the two irons shown in Figs. 7 and 8 is given at 7c and 8E for each diameter of bar, each point being the mean of three readings on the shank of the tensile bar. Obviously, therefore, the relation between Brinell hardness and tensile or transverse strength even for the same composition and conditions of melting, depends upon the size of standard test-bar employed.

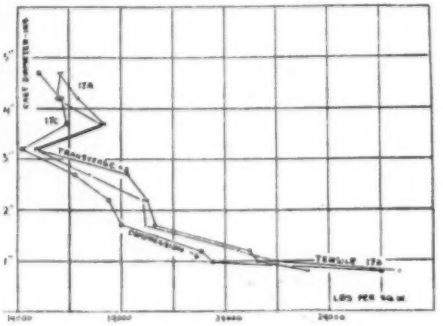

FIG. 17.

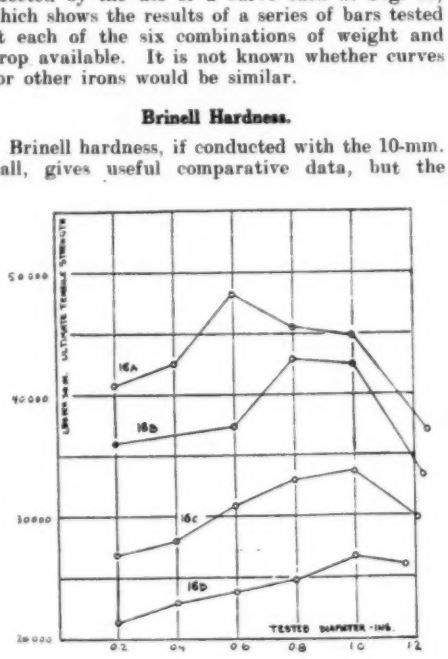

FIG. 16.

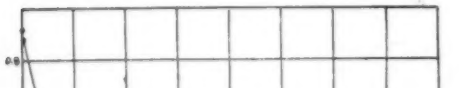

FIG. 19.

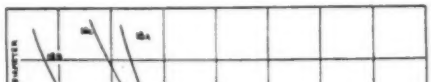

FIG. 18.

FIG. 16.—Tensile strengths of four foundry irons at various machined diameters, 1.2-in. cast bars.
FIG. 17.—Transverse tests on series shown in Fig. 9 at 0.8 in. dia. and tensile and compression at 0.564 in. dia. dia. plotted against cast diameter.
FIG. 18.—Suggested variation of strength with cast diameter at various tested diameters.
FIG. 19.—Repeated impact test. Relation between energy of blow and number of blows to fracture for the same iron.

Fatigue Tests.

Although comparatively little has been done in Great Britain on fatigue of cast iron, the results obtained at Illinois[23] have been followed with interest. Prof. C. H. Bulleid, of University College, Nottingham, has done a number of Wöhler fatigue tests on cast iron, and in conjunction with the B.C.I.R.A., a more systematic examination has been begun.

Conclusions.

(1) The proper correlation of mechanical tests and comparison necessitates the use of standard bars of specified shape and size and standard test procedures, preferably on an international basis. The 1.2-in. dia. bar, representing a large proportion of castings made, and accepted in the leading industrial countries, is particularly suited for experimental work.

(2) Under constant melting conditions grey irons of the same composition vary continuously in strength (transverse, tensile, fatigue, compression and hardness) with section, strength diminishing as section increases.

(3) Under constant melting conditions grey irons in the same size of bar vary continuously in strength (transverse, tensile, fatigue, compression and hardness) with composition (silicon content) strength increasing within the grey range as silicon diminishes.

(4) Differences in strength between grey irons of same composition and same size of bar are an index to differences in melting conditions.

(5) Variation in strength of a series of bars cast at different diameters is shown equally well by tests at the cast size or at a constant machined diameter, but the latter are lower on account of stock removed; the extent of the difference depends on the nature of the iron tested. Skin machining increases the strength of grey cast-iron bars.

(6) Transverse, tensile and compressive tests measure the same basic property of grey iron and for standardised tests on the same size of bar bear a constant ratio to each other for the same iron melted under the same conditions. Approximately the transverse is double and compression four times the tensile strength.

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Structure of Hypoeutectoid Steel.

INFLUENCE OF RATE OF COOLING.

A Paper (Technical Publication No. 299) on the "Influence of Rate of Cooling on Dendritic Structure and Microstructure of Some Hypoeutectoid Steel," prepared by MESSRS. ALBERT SAUVEUR and C. H. CHOU, has been issued by the American Institute of Mining and Metallurgical Engineers describing experiments which were conducted in order to study the influence of the rate of cooling through and below solidification on the dendritic structure (macrostructure) and microstructure of some hypoeutectoid steels. The steel selected was of commercial grade and had the following composition: C, 0.40 per cent.; Mn, 0.85; Si, 0.70; P, 0.099; S, 0.043. After melting in vacuum in an Arsem furnace, the various samples were allowed to solidify and to cool to room temperature. Samples were obtained representing all possible combinations of slow and fast cooling through the various ranges of temperatures indicated, namely: (1) Zone of solidification or primary crystallisation, (2) zone of granulation, and (3) zone of secondary crystallisation. The designations of the various samples readily indicate their treatment, as will be apparent from Table I.

TABLE I.—*Rate of Cooling of Samples.*

Designation of sample.	Region of temperature.		
	Zone of solidification.	Zone of granulation.	Zone of secondary crystallisation.
SSS	slow	slow	slow
SSF	slow	slow	fast
SFS	slow	fast	slow
SFF	slow	fast	fast
FSS	fast	slow	slow
FSF	fast	slow	fast
FFS	fast	fast	slow
FFF	fast	fast	fast

Sample SSS was slowly solidified and cooled to room temperature in the crucible in which it was melted, and the dendrites were sharp and distinct. The microstructure was of the Widmanstätten type with coarse ferrite bands in places.

Sample SSF was allowed to cool slowly in the furnace until a temperature of some 900 deg. C. had been reached, when the crucible and its contents were removed from the furnace and cooled in air to room temperature. The dendritic structure was not unlike that of the previous sample, but the microstructure was decidedly of the network pattern. The meshes were sorbitic rather than pearlitic.

Sample SFS, after reaching a temperature of about 1,300 deg. C. in the furnace, was removed and cooled in air to a temperature of about 850 deg., when it was placed in a furnace previously heated to 850 deg. and cooled slowly with the furnace to room temperature. The microstructure was of the Widmanstätten type.

Sample SFF was removed from the furnace after it had reached a temperature of some 1,300 deg. C. and cooled in air to room temperature. A very clear dendritic structure was obtained, and a distinct network microstructure.

After sample FSS had been melted it was taken out of the furnace and cooled in air to a temperature of some 1,300 deg. to 1,350 deg. C., when it was placed in another furnace which had been preheated to a temperature of 1,000 deg. C. and allowed to cool to room temperature in that furnace. The macrostructure was finely dendritic and the microstructure of a mixed type, neither clearly of a network pattern nor Widmanstätten type.

Sample FSF was removed from the furnace when still liquid and cooled in air to a temperature of some 1,300 deg. to 1,350 deg. C., placed in another furnace, preheated to 1,000 deg. C., cooled in that furnace to 850 deg. C., when it was taken out and the cooling completed in air. The macrostructure was finely dendritic, while the microstructure exhibited a coarse ferrite network.

The melt of sample FFS was removed from the furnace, solidified and cooled in air to a temperature of about 850 deg. C., when it was placed in another furnace preheated to 800 deg. C. and allowed to cool to room temperature. The macrostructure was finely dendritic and the microstructure of a mixed type.

Sample FFF was removed from the furnace when still liquid and allowed to cool in air. The macrostructure was finely dendritic and the microstructure of a network pattern with thick ferrite boundaries.

In order to obtain slower rates of cooling, a melt of the same steel, to be designated hereafter as SSS_1, was solidified and cooled in the furnace in which it was melted, at the rate of 1 deg. C. per min. through suitable regulation of the current. The resulting microstructure was distinctly of the Widmanstätten type. The macrostructure was finely dendritic. It seems reasonable to assume that this absence of marked dendritic segregation was due to the diffusion of the impurities made possible by very slow cooling.

Influence of Impurities.

In order to ascertain to what extent the impurities found in commercial steel affected the macrostructure and microstructure of cast ingots these experiments were repeated with a steel of great purity, except for its silicon content. It had the following composition: C, 0.53; Mn, 0.058; Si, 0.205; P, 0.006; S, 0.034 per cent. It was substantially free from manganese. The commercial steel, as stated, contained 0.85 per cent. manganese and 0.099 per cent. phosphorus. The dendritic structure was fine and indistinct in all samples—after slow cooling through the thermal critical range the microstructure was more distinctly Widmanstätten than the structure of the corresponding samples of the commercial steel—all samples cooled through their critical range had a network structure.

It was generally possible to bring out clearly the macrograins resulting from the granulation of the dendrites in cooling through the granulation range by etching deeply with 10 per cent. nital, followed by polishing until only the grain boundaries remained. It is believed that they indicated the size of the austenite grains, as they exist immediately before their breaking-up into a ferrite-cementite aggregate.

Conclusions.

From the results reported in this Paper and from those of many other experiments, the following conclusions appear justified. While these conclusions refer only to the two steels investigated, it is believed that they would be found applicable to carbon steels in general: (1) The dendrites of the commercial steel are considerably larger and more clearly defined than those of the pure steel. (2) For like treatment the macrograins of the commercial steel are smaller than those of the pure steel. (3) For like treatment the Widmanstätten structure after slow cooling through the thermal critical range is much more pronounced in the pure steel. (4) The dendrites of the four samples of commercial steel slowly solidified are substantially larger than those of the four samples more rapidly solidified. In the pure steel there is no appreciable difference between the dendritic pattern of the samples slowly and rapidly solidified. (5) The slower the cooling through the granulation range, the larger the macrograins. (6) The larger the macrograins, the more marked the Widmanstätten type of structure after slow cooling through the thermal critical range. (7) The less pronounced the dendritic structure, the more pronounced the Widmanstätten structure after slow cooling through the thermal critical range. (8) Slow cooling through the thermal critical range induces the formation of a Widmanstätten structure; rapid cooling induces the formation of a network structure.

Carburising and Graphitising Reactions between Iron - Carbon Alloys, Carbon Monoxide and Carbon Dioxide.*

By M. L. BECKER.

(*Summary.*)

This investigation was carried out for the British Cast Iron Research Association, the ultimate object being to throw light upon some of the abnormalities in the behaviour of cast irons at elevated temperatures, as well as to suggest possible means for inhibiting growth, scaling, etc., of cast irons and steels.

The object of the present work was to determine the quantitative influence of the temperature and carbon content of solid solutions upon the composition of a gas consisting of CO and CO_2. Before attempting this, it appeared advisable to make certain that a simple hyperbolic relationship could be used to calculate the effect upon the gas composition of the variations in pressure likely to be met with during the course of the experiments.

A further object in view was to compare the carbon-vapour pressures of carbon and of iron carbide by means of the gas equilibria. It was also intended to determine the quantitative influence of other elements, such as silicon, manganese, sulphur, phosphorus, nickel, chromium, etc., upon the gaseous equilibria. It was felt that the proposed investigation might assist in explaining some of the abnormalities met with in connection with the graphitisation and oxidation of cast irons, as well as suggesting possible means for inhibiting growth, scaling, etc. It was also anticipated that the results might be applied to the more accurate control of carburisation and decarburisation of steels and white irons.

The following is a summary of the results of the investigation:—

(1) The theory underlying the oxidation, carburisation, and graphitisation of steels and irons in the presence of CO and CO_2 has been briefly discussed.

(2) A new method is described by which equilibria between the gases and carbon or steel may be studied. In this method, the partial pressure of CO_2 in the reacting gas is controlled by varying the temperature of a dissociating carbonate. By subtracting the known CO_2 tension from the measured total pressure, the CO tension is obtained. From these values the composition of the gas in equilibrium with carbon or steel may be deduced.

(3) The method has been used to determine the compositions of the gas in equilibrium with steels of varying carbon content.

(4) The composition of the gas in equilibrium with graphite has been found to vary over a range of temperature from 650 deg. to 1,000 deg. C. in accordance with determinations made by previous workers.

(5) The gas in equilibrium with iron carbide plus saturated solid solution is found to be richer in CO than that in equilibrium with graphite at the same temperature. The carbon-vapour pressure of iron carbide must, therefore, be higher than that of pure carbon, at any rate between 650 deg. and 1,000 deg. C. It would therefore appear that graphite is stable with respect to iron carbide over this range of temperature. This inference is not in accord with the views of other investigators, who considered the carbon-vapour pressure of carbide to be lower than that of graphite at temperatures above about 800 deg. C.

(6) The influence of silicon, manganese, nickel and chromium upon the equilibria has also been investigated.

* From a Paper read at the annual meeting of the Iron and Steel Institute.

The Dutch Pig-Iron Industry.

The announcement that the Belgo-French-Luxemburg Pig-iron Convention has just reduced the price of foundry iron for export to Holland by 1s. the ton, to £3 6s. 6d., at the Dutch frontier, lends some interest to the subject of the production in and export of pig-iron from Holland. Some information on the subject is contained in the quarterly report of the Amsterdam Bank in the course of an article by MR. G. A. KESSLER, director of the Kon. Nederlandsche Hoogovens en Staalfabrieken, of Ymuiden.

At the outset the director points out that the market for iron and steel products in Holland is important, the country consuming annually about 100,000 tons of pig-iron and 1,000,000 tons of steel. This fact indicated the need for the establishment of a national industry capable of meeting the home requirements. However, with its free trade policy Holland is a popular market for its iron- and steel-producing neighbours and a traditional dumping ground, so that something special was required to convert the vague demand for a national iron and steel works into a commanding necessity. A strong incentive was offered by the world war, which had cut off Holland for years from the source of raw materials and led to the maturing of the plan of Mr. H. J. E. Wenckebach, the founder of the undertaking, who succeeded in raising the necessary capital of 25,000,000 fl. (12 florins to the £), thanks to the support of numerous industrialists, the leading banks and the Government, which by a special law was authorised to participate to the amount of 7,500,000 fl. Moreover, the city of Amsterdam, on its own initiative, promised a contribution of 5,000,000 fl., provided that the works were established at Ymuiden, at the head of the North Sea Canal, so that the capital was then increased to 30,000,000 fl.

Site of Blast-Furnace Works.

The site of the Netherlands blast-furnace works was determined, in so far as its ore basis was concerned, through the favourable situation of the chosen site in relation to the streams of ore flowing from various directions to the iron and steel industry in Western Europe. This was one of the factors which prescribed the establishment of the works on the coast at Ymuiden. Moreover, this location was demanded by the necessity for disposing of a large part of the production in oversea markets. The qualities which are produced are both phosphoric brands and hematite, together with steel-making pig-iron. The production has been as follows, in metric tons, since the starting of the works:—In 1924, 91,100 metric tons; 1925, 109,300 tons; 1926, 142,500 tons; 1927, 203,700 tons, 1928, 258,200 tons; and in 1929, 253,800 tons.

During 1924 and 1925 only one blast furnace was in service, but in April, 1926, a second furnace was blown in, and with occasional interruptions two furnaces have been in operation since that date. Quite recently a third furnace has been completed, this having a larger capacity than either of the other two, namely, 500 tons per day. The third furnace is being kept in reserve for the time being. The inland consumption and the share of Ymuiden pig-iron sold have been as shown in Table I in the last four years:—

TABLE I.—*Home Consumption of Dutch Pig-Iron.*

	1926.	1927.	1928.	1929.
	Metric tons.	Metric tons.	Metric tons.	Metric tons.
Consumption.. ..	67,200	71,400	89,500	89,500
Sales of Dutch iron ..	30,000	39,700	53,900	59,000
Sales in percentage of the consumption ..	45	56	60	66

Pig-Iron Exports.

As an exporting country, the director states, with its Ymuiden works, Holland has become a factor with which the world market has to reckon. In its search for foreign markets the company has not only met with tariff walls but also the rivalry of competitors, who have been able to depress the price level in the world markets owing to the protection of their national industries, and in some cases even with the aid of State subsidies. The Dutch exports of pig-iron have been as shown in Table II.

TABLE II.—*Exports of Dutch Pig-Iron.* (*Metric Tons.*)

	1926.	1927.	1928.	1929.
	Tons.	Tons.	Tons.	Tons.
To United States ..	56,300	29,100	28,700	21,300
,, Great Britain ..	20,400	11,700	14,100	25,600
,, Belgium	11,200	36,100	58,900	35,600
,, France	1,300	22,400	50,700	39,000
,, Germany	—	26,600	27,000	4,100
,, Denmark	1,600	5,100	6,800	17,100
,, Dutch East Indies	1,700	2,300	1,800	3,000
,, Other countries ..	20,200	17,200	28,500	29,000
Total	112,700	150,500	216,500	174,700

As a consequence of the adverse factors just mentioned—the director states—the financial results of the exports in general have been unsatisfactory.

Production of Coke.

Since the production of over 100,000 tons of pig-iron in 1925, the manufacture of coke at the company's battery has simultaneously increased. In this connection it is mentioned that good progress has been made in the utilisation of by-products. It had been intended to supply the surplus coke-oven gas for consumption at a long distance, as in the case of the Ruhr mines and in that of the Maurits State mine; but the scheme has not yet materialised. In the circumstances the company, in co-operation with the Batavian Petroleum Company, has embarked on the production of synthetic ammonia on the latter's premises, where all the surplus gas is now consumed.

Within a short time the by-products of the blast furnaces—the blast-furnace gas and slag—will also be profitably used. A portion of the gas is already used in the works, but use for the whole gas output will first be found when the Provincial Electricity Undertaking for North Holland has completed the central station now under construction in close proximity the blast-furnace works, which will use the gas for the production of current by the end of 1931.

Applications for Trade Marks.

The following list of applications to register trade marks is taken from the "Trade Marks Journal":

"AL-DUR-BRA."—Aluminium brass alloys. Charles Clifford & Son, Limited, Fazeley Street, Birmingham.

SHIELD, depicting head of man in armour (device).—Metals. Barronia Metals, Limited, 59, Parsons Green Lane, London, S.W.6.

"VALNICK."—Metals. W. G. James, "Woodside," Harewood Road, Chalfont St. Giles, Buckinghamshire.

"LISTER."—Auto-trucks. R. A. Lister & Company, Limited, Long Street, Dursley.

"HOPKINSONS."—Valves, boiler feed-water regulators, expansion joints, gauges, thermostats, signalling apparatus, etc. Hopkinsons, Limited, Wheathouse Road, Birkby, Huddersfield.

"GALVO."—Wire netting and fencing. The Galvo Company, Limited, Coneygree Road, Tipton.

"ENGINALITIES." — Machinery belting, belt fasteners, bolts and nuts, implements and tools, cutlery, etc. Messrs. W. H. Willcox Company, Limited, 38, Southwark Street, London, S.E.1.

"RUMEL."—Metals. Rustless Metals, Limited, Cheetham Street, Middleton, Manchester.

THE HUNSLET ENGINE COMPANY, LIMITED, Leeds, have received an order for six locomotive boilers from H.E.H. the Nizam's State Railways Board.

German Union of Steelworks.

The following figures show the aggregate new (and old) amounts of allotments (in metric tons) of the members of the German Union of Steelworks of Düsseldorf:—

A PRODUCTS. — Semi-products, 1,165,338 (908,762); permanent-way materials, 2,381,237 (2,282,641); shapes, 1,230,780 (1,205,909); total A products, 4,777,355 (4,397,312) metric tons.

The great increase of 380,043 tons in the total is principally due to the fact that 6 of the members had formerly no allotments at all in A products.

BARS.—The Bar Syndicate's new allotment is 3,127,464 tons in the inland trade and 1,026,153 tons in the export trade. Total bars, 4,375,647 (4,158,955) metric tons. The increase of 216,692 tons is due mainly to the Maxhütte's claim for a share for its new works at Unterwellenborn.

HOOPS.—Total allotments of the Syndicate, 865,159 (1,115,829) tons. The explanation of the decrease of 250,670 tons is that the figures only represent the inland quota; the amount of the export quota has not yet been settled.

PLATES.—The total allotments of the members of the Plate Syndicate amount to 1,709,578 (1,682,578) tons. This item shows little change. The increase of 27,000 tons is due to a substantial addition to the quota of the Mannesmann Company and a small increase in the Borsig quota, while the share of the Vereinigte Stahlwerke A.G. has been reduced.

MEDIUM SHEETS.—The inland allotment is 229,632 tons and the export allotment 103,852 tons; total, 333,484 tons.

THIN SHEETS.—The Thin Sheet Union's allotment for the inland trade is 1,196,426 tons.

WIRE RODS.—The aggregate share of the German Wire Rod Works A.G. is 1,570,322 (1,540,896) tons. The increase of 29,426 tons is due principally to a large increase in the share of the Gutehoffnungshütte. Several other members had their share slightly increased. The share of the Röchling Company has been slightly reduced, but as a compensation this company's exports to France and deliveries in the Saar district are free and not included in the quota. This company enjoys the same privilege as regards bars.

The Moulding of Large-Size Marine Steam Cylinders.

(*Continued from page* 434.)

core which covers the small "mould" must have a hole in the centre the size of the print.

Cores.

It is doubtful if any firm has yet the courage to use oil-sand on large-size marine-cylinder castings. Yet there ought to be no need for fear in using oil-sand cores, if the materials are mixed to proper requirements, and the core thoroughly dried. There is no material used in foundry practice that can equal oil-sand for cores of cast iron, especially for port cores. It eliminates almost entirely the use of vents. It will stand up to any amount of rough usage during the process of assembling, and will leave the casting with the minimum of trouble. The suggestion thus far are practical, and in each case capable of application.

Another suggestion, though perhaps not so practical, but taking us into the realms of speculation—it ought to be possible to build up a loam mould without any body pattern whatever. This could be done by using large-size loam blocks. The face of these blocks would be the same sweep as the pattern. A gauge would be set on an arm and the blocks built up much in the same way as building a wall. This idea, shown in Fig. 7, would require a good deal of study and calculation before it could be applied. It is just possible that it contains the "germ" which, if brought to fruition, would certainly make great alterations in the moulding of large-size cylinders.

The sketches and diagrams illustrate the main points of this Paper.

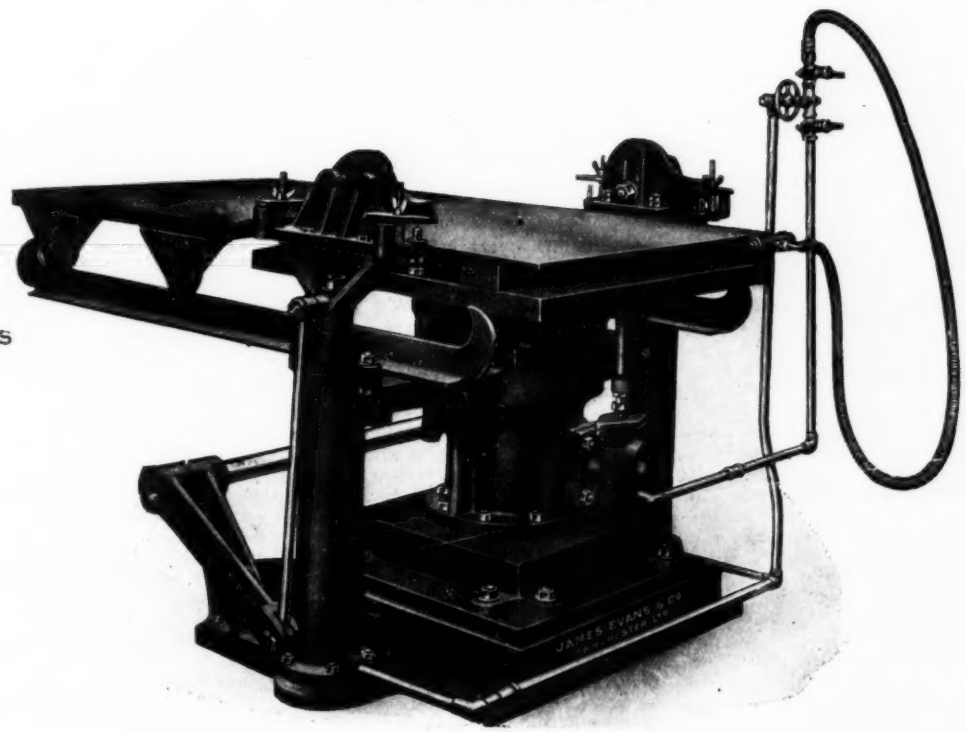
TYPE "C"

JAR RAM MOULDING MACHINE

with Turnover Pattern Plate.

For Pneumatic Power.

TWO MACHINES IN ONE.



UNSKILLED LABOUR ONLY REQUIRED.

The above machine illustrates a Jar Ram Machine with Turnover Pattern Plate which can also be used for Stripping Plate Work.

The machine has been designed to combine the two distinct features above mentioned, and is practically two machines in one, equally suitable for steel, iron, etc.

The machine as illustrated is arranged for work that requires turning over, such as steel moulding. And while the turnover arrangements are intended for general repetition work, by detaching the turnover plate from the trunnion brackets the machine can be used for stripping plate work by attaching the stripping plate to the trunnion brackets. Or, on the other hand, by removing the trunnion brackets as well, the table can be used for jolting general jobbing work.

A very important feature of the machine is the simplicity with which the intensity of the Jolt can be regulated when the operator has become accustomed to the use of the machine, which takes but an hour or so. The valves all being on the exterior of the machine are easily accessible, and there is an adjustable arrangement that will allow the jolt to be varied between 1½ in. to below ¼ in. This being done without disturbing any part of the machine.

The machine is supplied with Withdrawal Carriage, Vibrator, and Blow-off Nozzle complete. It is substantially constructed to stand heavy wear and tear, and requires a minimum amount of skill to operate.

Another important feature of the machine is in the arrangement of the hard wood anvil block for receiving the shock. The blocks being carried well down the machine in a specially designed annular chamber give considerable relief to the foundations. It also provides against the possibility of fracturing the jolting table. Pitch pine blocks are also inserted between the foundation plate and the machine bedplate to assist in the relief on the foundations, and these features considerably improve the working advantages of the machine.

IT IS ALSO ENTIRELY OF BRITISH DESIGN AND MANUFACTURE.

JAMES EVANS & CO. (M/c) LTD.

Britannia Works, BLACKFRIARS, MANCHESTER.

The Scrap Metal Scarcity.

By "Onlooker."

Since the slump in copper prices during April and early May quite a change has come over the scrap metal position, for while during the first three months of this year there was enough old metal and to spare at really reasonable prices, the situation to-day is that margins below new metal values are not anything like so adequate to the buyer, and certain classes of material are difficult to come by except for delivery some months ahead, and even that is not always easy.

During the months preceding the break in copper the refineries were sweeping up all the old metal they could lay their hands on, and by the end of April the reservoir was practically empty. This "clean-up" in the States is supposed to have accounted for many thousands of tons of secondary copper, but probably did not have much effect upon the situation here, which was already bad enough by virtue of the fact that although what *was* available was freely offered and even pressed for sale, the total quantity to be disposed of was far from large. At that time buyers were very shy and the shortage was not apparent to most people, but after the drop inquiries have increased, and dealers are being hard put to it to find sufficient material for their customers.

To some extent the situation looks worse than it is because many holders of copper scrap to-day are holding for a rise, and in passing it may be said that they look like holding for a long time. In spite of that, old copper is certainly not plentiful if only because trade has been depressed for so long by the imposition of an unduly inflated price that replacements have been held up, and dismantled material is therefore very scarce. The reduction in the quotation for the red metal is certainly going to help, but some time must elapse before (especially in view of the general depression) trade revives sufficiently to bring back a steady flow of secondary copper. What is further aggravating the present scarcity and helping to keep up values is the fact that a certain number of merchants sold short before the slump, and in now seeking to cover they are taking material off the market at prices practically equivalent to the electro quotation. In Germany, where, prior to the break in the copper price, sales of scrap had been exceptionally heavy, dealers have been driven to the expedient of sending in refined copper in satisfaction of contracts for old metal. Even so they are probably able to net a handsome profit.

When copper first broke 18 cents, values of brass scrap came back rather unwillingly, but buyers held off for the most part until the Export Association brought its price down to 12½ cents, and brass scrap values sank to the lowest seen, at any rate since the war. Then there was something approaching a stampede on both sides of the Atlantic, and consumers covered heavily for some months ahead, as a result of which there is not now a great deal of stuff about for early dates. What applies to copper is true also to some extent of brass, especially of the best-grade stuff, for dealers who had sold short in the early days of April for May delivery have been able to secure cover by paying a price which assures them of an ample profit, and yet by comparison with new metal values looks dear. Latterly there has been something of a lull in activity, but prices keep firm in view of the well-sold position of the market, and there seems little likelihood of much recession in any quotations.

Aluminium scrap—at any rate the lighter varieties—appears to be fairly plentiful, possibly because the situation in the white metal is not dissimilar to that in copper before the slump, and consumers, regarding the price of virgin metal as too high, are endeavouring to replace it as far as possible by using scrap, but only at a value which fits in with their idea of what virgin aluminium ought to cost. Dealers in secondary aluminium, who have latterly found demand rather slow, are quite glad to meet this inquiry to the best of their ability, and are not forgetting to push the claims of remelted ingots at the same time.

Nitrogen in "Technical Iron."

A Paper on "Nitrogen in Technical Iron," by Herr Werner Köster, of Dortmund, is published in a recent issue of "Archiv für Eisenhüttenwesen," as a communication of the Research Department of the Vereinigte Stahlwerke A.-G., Dortmund. According to the author, the nitrogen present in technical iron remains in over-saturated solid solution even when the steel is cooled slowly; it is separated only when the steel is heated to low temperatures for a lengthy period. At 100 deg. C. the separation is not complete for about 14 days. The most striking change of properties during the process is that of the magnetic behaviour of the steel, known as magnetic ageing.

The isothermal change in the magnetic properties and the electrical conductivity of a slowly-cooled basic steel was observed at tempering temperatures of 65 to 680 deg. C. The coercive force increases most at 100 deg. C.; beyond that point the final values decline as the tempering temperature is increased. Beyond that temperature at which the solubility of the nitrogen corresponds to the nitrogen content of the steel no further changes occur. The increase in coercive force is accompanied by an increase in conductivity, which is also greatest at 100 deg. C., but diminishes beyond the same temperature as that at which the increase in coercive force begins. The change in coercive force is nearly proportional to that of the conductivity and consequently to the quantity of nitrogen separated. The change in coercive force caused by the quantity unit of the nitrogen diminishes rapidly, however, with the tempering temperature. This indicates that the magnitude of the nitride separations increases as the tempering temperature rises.

This is confirmed by observation of the structure. At 100 deg. C. the nitrogen is separated in the form of fine specks, and at higher temperatures in that of small needles. The quantity separated diminishes with the tempering temperature.

The change in the coercive force of different steels under the same tempering conditions is proportionate to the nitrogen content of the steel. This applies also to the change in conductivity. The separation of the nitrogen causes a marked decrease in tensile strength and hardness, while the torsional strength and rapidity of solution in acids increase considerably. The contraction of area and elongation are only slightly affected. The position of the steep drop in the notch-toughness temperature curve is not altered, whereas at the peak the notch-toughness is somewhat increased. The following figures show the changes in certain properties due to the separation of 0.01 per cent. N at 100 deg. C.:—Specific electrical resistance = $-0.0013 \frac{\Omega \cdot mm^2}{m}$; coercive force = +3.2 Gauss; tensile strength = −2.3 kg./sq. mm.; torsional strength = +25 per cent.; rapidity of solution in acids = +20 per cent.

The nitrogen content is an important cause of the difference in the property values of open-hearth and basic Bessemer steel. The solubility of the nitrogen in technical iron at 100 deg. C. is about 0.001 per cent.; at 200 deg. 0.005, at 300 deg. 0.01, and at 400 deg. 0.02 per cent.

The separation of the nitrogen is dependent on the preliminary treatment of the steel. The solubility values given above were determined in basic open-hearth steel, basic Bessemer steel and wrought iron. Acid open-hearth steel and basic steel produced by special processes, such as Izett steel, are not subject to magnetic ageing. The solubility of the nitrogen can be increased by silicon and aluminium additions to the steel. The separation of the nitrogen from the supersaturated solid solution in alpha iron is accelerated by cold deformation. The blackening which occurs in the areas of stress is due to the difference in the speed at which the nitrogen is separated in the deformed and non-deformed areas. The accelerated separation of the nitrogen by cold deformation is demonstrated by micrographs of the structure showing separations along the flow lines of deformation.

The appearance of stress figures after annealing above the temperature at which the nitrogen present is dissolved is dependent upon the speed of cooling. The areas deformed below the recrystallisation limit retain the capability of accelerated separation of the nitrogen. This can, however, be interrupted by quenching. In a freshly-recrystallised structure, on the other hand, no separation will take place, not even with slow cooling. Recrystallised zones consequently remain of a light colour when etched. Stress figures occur only in magnetically ageing steel, *i.e.*, steel which is capable of separating nitrogen. They are a phenomenon independent of the process of mechanical ageing.

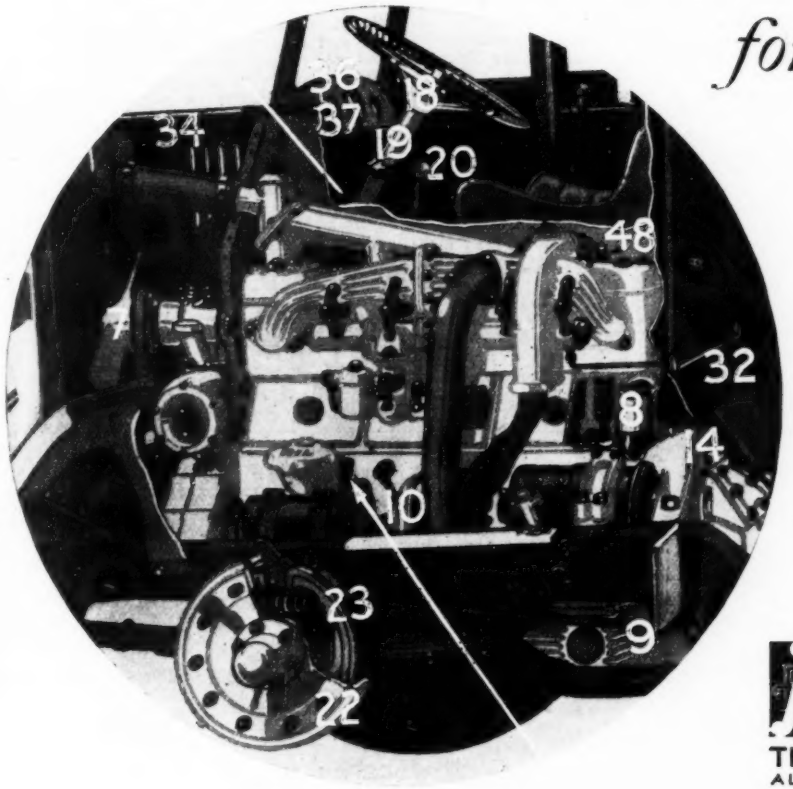
Manufacturing Large Refractory Blocks.

The Wedgwood bicentenary celebration meeting of the Ceramic Society was held in London recently, when Dr. H. Ackerman and Dr. H. Knuth read a Paper on "Improvements in Preparing and Moulding Refractories, especially for Manufacturing Large Blocks," in the course of which they described the "S. u. G." process for manufacturing bricks and blocks; a process which has been extensively developed in Germany during the last five years. This is the first Paper to give a description of this process. Dried and finely-ground clay is mixed with water and a suitable electrolyte is added to induce a colloidal state. A definite quantity of graded slip is added to the non-plastic material. The porosity of the finished block is determined by the grading of the grog, as the size and shape of the pores is not affected by the bonding medium. Hence the porosity of the burnt brick is determined beforehand by the grading of the non-plastic material. The "S. u. G." body is moulded by application of powerful mechanical pressure (stamping or beating, etc.).

Large tank blocks, made of the "S. u. G." body, can be placed in the kiln three or four days after moulding, as compared with the three to six months usually required for drying similar blocks made by other methods, and smaller bricks may be placed in the kiln directly after moulding. The new moulding operation also takes much less time. It is further claimed that the finished blocks may be made on a works scale with a tolerance of 0.5 per cent. of the given dimensions, and that such blocks may be used without any dressing in building furnace walls with narrow joints. By appropriate grading of the material, increased resistance to sudden temperature changes as well as to slag attack may be secured. Finally, the "S. u. G." process can be applied with advantage not only to grog material but also to special refractories made of corundum, zirconia, silicon-carbide, sillimanite, etc.

New Rail Mill in Japan.—It is reported from Yokohama that a large rail mill is to be erected, equipped up to date, at Horaoka. It is to have a yearly capacity of 300,000 metric tons. The mill is to be completed in two years, commencing with the fiscal year 1931-1932.

F.T.J. 13. 6. 30.



for light castings,

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The lightened portions of this cut-away sketch indicate the extent to which aluminium and aluminium alloy castings are adopted in omnibus engine, transmission and controls.

The lightness of the metal is usually the prime reason for its employment. Ease in casting, economy in machining and high thermal conductivity increase its attractiveness to designers.

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WIRE BRUSHES.
BELLOWS.

PLUMBAGO
CORE GUM
WHITE DUST
COAL DUST
REQUISITES

Trade Talk.

SCOTTISH SHIPBUILDERS launched during May 46 vessels, of a total of 66,209 tons. The Clyde output consisted of 36 vessels, of a total of 55,644 tons.

THE ALBION MOTOR CAR COMPANY, LIMITED, Glasgow, have received an order for 59 vehicles for the Government of India. The total number of this type of vehicle which the Albion Company have supplied to India is now 280.

A MESSAGE FROM CAIRO states that nine British and Continental firms have presented tenders for the construction of the bridge at Benha, in Lower Egypt. The lowest is that of Messrs. Dorman, Long & Company, Limited, at £E166,732.

MESSRS. WILD-BARFIELD ELECTRIC FURNACES, LIMITED, of Elecform Works, North Road, Holloway, London, N.7, have been appointed distributors for the Vickers hardness-testing machine, which utilises the pyramid diamond instead of a ball.

THE PENTYRCH STEEL AND TINPLATE WORKS, Taff's Well, which have been idle since August, 1915, are to be restarted almost immediately, and will eventually, it is stated, give employment to about 300 men. A new company has been formed to carry on the works.

MESSRS. NAPIER & MILLER, LIMITED, Old Kilpatrick, have launched the steel screw steamer "Cité de Levis," built for the Levis Ferry, Limited, Quebec. The vessel has been specially constructed for the ferry service between Levis and Quebec, and is strengthened to withstand ice.

A CONSIGNMENT OF ABOUT 1,000 tons of machinery for Russia was shipped on June 6 from the Clyde by Messrs. Babcock & Wilcox, Limited, Renfrew. This included boilers, pipe work, valves and general boiler-house accessories and is part of a volume of work which will occupy the Renfrew firm until the end of 1930.

THE BOARD of the Wigston Foundry Company, Limited, whose works are at South Wigston, Leicester, has been reorganised, with Mr. S. L. Wright as chairman and Mr. Guy Barrett and Mr. W. Ralph Bates as managing directors. A programme of modernisation of the works, including the addition of new machine shops, is now in progress.

THE INSTITUTION OF MECHANICAL ENGINEERS is to visit the works of Messrs. R. A. Lister & Company, Limited, at Dursley, during its summer meeting, which is being held in Bristol during the first week of July. Among other productions, the visitors will be shown the new cold-starting Diesel engines which Messrs. Lister are now making on mass production lines.

THE ENGLISH STEEL CORPORATION, LIMITED, have now concentrated most of their steel-casting work at the Grimesthorpe Foundry, Sheffield, one of the works which Messrs. Cammell, Laird & Company, Limited, brought into the rationalisation scheme. The foundry is laid out for a weekly production of about 200 tons of castings, and, in addition to other work, is turning out large quantities of castings for dredger work.

THE BATTERY of four blast furnaces with the associated ironstone mines, owned by the Islip Iron Company, of Thrapston, Northants, is being incorporated in the organisation of Messrs. Stewarts & Lloyds, the Clydeside and Midland ironmasters. It is stated that no important change in the management is contemplated. The Islip Company was the single unit that stood outside the Central Pig Iron Producers' Association.

MESSRS. SCOTTS' SHIPBUILDING & ENGINEERING COMPANY, LIMITED, Greenock, launched the single-screw cargo steamer "Dalryan" for the United Steam Navigation Company, Limited. The vessel has been built beyond Lloyd's highest class, and the propelling machinery consists of one set of inverted quadruple-expansion four-crank engines of the surface-condensing type. Superheated steam at 250 lbs. pressure will be supplied from three single-ended boilers working under Howden's system of forced draft.

ALL FOUR BLAST FURNACES at the Devonshire Works, Derbyshire, of the Staveley Coal & Iron Company, Limited, are now in commission, No. 1 furnace having been relighted after being stopped for repairs for about two months. The associated foundries of the company are consuming a full tonnage of pig-iron, notably the cast-iron pipe foundries, which are executing a number of orders for iron pipes for gas companies and municipal gas and water undertakings, as well as orders for pipes for a Cairo sewerage scheme.

MINING & INDUSTRIAL EQUIPMENT, LIMITED, 11, Southampton Row, London, W.C.1, report the receipt of new orders from English firms for three screens, for screening sand, a 7-ft. Raymond air separating plant, for separating carbonate of magnesia, a Ro-tap sieve shaker, and a No. 3 Raymond pulveriser, for grinding hydrated lime; from a Scottish firm, an order for a Ro-tap sieve shaker; from Yugo-Slavia, an order for a Ro-tap sieve shaker; and from France, orders for a Hum-mer screen, a two-roller Raymond pulveriser, and a Hardinge mill.

THE CENTRAL ELECTRICITY BOARD have recently placed contracts, amounting approximately to £326,000, for works in connection with various schemes, including the following:—For 66-kv., 33-kv. and lower voltage transformers in the areas of the North-West England and North Wales and Mid-East England schemes—with the British Thomson-Houston Company, Limited; the Brush Electrical Engineering Company, Limited; the English Electric Company, Limited; Ferranti, Limited; and Messrs. C. A. Parsons & Company, Limited. For oil-filtering storage equipment for outdoor transforming stations in the area of the Central England scheme—with Super-Centrifugal Engineers, Limited, London.

IT WAS ANNOUNCED at the annual meeting of the British Non-ferrous Metals Research Association at Birmingham that the Department of Scientific and Industrial Research had agreed to make a grant of £1 for every £1 subscribed above £8,000 up to £16,000. Thus, if the latter figure is reached, the Association will receive another £8,000. The report mentioned that the keenest competition from abroad came from countries where very active scientific and industrial research was in progress. Germany and the U.S.A. had made large provision for co-operative and industrial research, but in this country the extension of the work was hampered by lack of funds. Notwithstanding this, the results obtained had exceeded in importance and volume any previous yearly record.

PROFESSOR HENRY CLAY, Economic Adviser to the Securities Management Trust, and Professor of Social Economics in the University of Manchester, will give an address entitled "British Industry's Message to the World," at the 1930 Advertising Convention, Industrial Press Section, on June 24 next. Addresses will also be given by Mr. Holbrook Jackson, editorial director, National Trade Press, Limited, on "The Voice of Industry: The Trade Press"; by Mr. C. Pinkham, manager of the publicity organisation of the General Electric Company, Limited, who will discuss "The Service Expected from a Trade Journal"; and by Mr. P. Best, managing director of Messrs. Jas. Shoolbred & Company, Limited, on "The Trade Journal as a Link between Manufacturer and Distributor."

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION, LIMITED, have recently concluded an agreement with the Società Terni, of Terni and Genoa, Italy, relating to the system of open-hearth furnace construction and operation successfully developed at Terni, and with which very good results from the point of view of fuel consumption per ton of steel made have been obtained. Appreciably increased tonnage outputs per furnace have also been obtained, while the capacity of the furnace to produce any desired quality of steel has been fully demonstrated. The Wellman Company have the exclusive constructional rights for Great Britain, the British Dominions and many other steel-producing countries. The system involved may be either embodied in existing furnaces or in new furnaces immaterial of the capacity. Licences to employ the system have already been let in this country to Messrs. John Lysaght, Limited, Scunthorpe, the Consett Iron Company, Limited, and the Earl of Dudley's Round Oak Works, Limited, Brierley Hill.

Reports and Dividends.

Pease & Partners, Limited.—The directors announce that no dividend can be paid on the ordinary shares.

Armstrong, Whitworth Securities Company, Limited.—Net profit, £66,141, out of which has been appropriated £54,426 as provision against the trading losses of subsidiary companies, leaving £11,715 to be carried forward.

Lubricants.—When sharpening small tools on an oil stone, glycerine is a far better lubricant to use than ordinary mineral oil. It does not evaporate or clog as oil may do. An even better lubricant than glycerine is a mixture of equal parts of glycerine and alcohol, this being very efficient.

Contracts Open.

Birkenhead, June 18.—Wrought-iron tubes and fittings, cast-iron pipes and specials, brasswork, pipe and block tin, tools, bolts and nuts, iron and steel, for the Corporation. The Gas Engineer, Gasworks, Thomas Street, Birkenhead.

Chilmark, Tisbury, June 18.—140 tons of 3-in. and 4-in. cast-iron pipes, etc., for the Tisbury Rural District Council. Messrs. A. J. Martin, 108, St. George's Square, Westminster, S.W.1. (Fee £2 2s., returnable.)

Coventry, June 18.—Pumping plant, for the Corporation. Mr. H. Lapworth, 25, Victoria Street, Westminster. (Fee £3, returnable.)

Dewsbury, June 16.—Valves, penstocks and other ironwork, for the Corporation. Messrs. J. Diggle & Son, Hind Hill Street, Heywood, Lancs. (Fee £1 1s., returnable.)

Ellesmere, June 14.—2½ miles of 3-in. cast-iron spigot and socket water pipes, for the Rural District Council. The Council, 4, Victoria Street, Ellesmere.

Godshill, I. of W., June 17.—228 yds. of 3-in. main, for the Isle of Wight Rural District Council. The Council's Offices, 30, Pyle Street, Newport, I.W.

Istanbout, June 23.—High-speed steel, for the Administration Générale des Chemins de fer et des Ports d'Etat. The Department of Overseas Trade. (Reference A.X. 9,669.)

Richmond, Surrey, June 18.—Centrifugal pumps, etc., for the Town Council. Mr. H. P. Williamson, water engineer and manager, Hotham House, Heron Court, Richmond, Surrey. (Fee £5 5s., returnable.)

South Benfleet, Essex, June 23.—Three centrifugal pumps, for the Benfleet Urban District Council. Mr. W. E. Blizard, 9, Victoria Street, Westminster. (Fee £2 2s., returnable.)

Sunbury Common, Middlesex, June 30.—Centrifugal pumping engine, for the Metropolitan Water Board. The Chief Engineer's Department (Room 173), 173, Rosebery Avenue, E.C.1. (Fee £1 1s., returnable.)

Warsop, etc., June 24.—Water scheme, including the provision of cast-iron pipes, pumps, etc., for the Warsop Urban and Blackwell Rural District Councils. Messrs. A. H. Elliott and B. C. Westwick, joint engineers, Gilcroft Chambers, Church Lane, Mansfield. (Fee £2 2s., returnable.)

Personal.

THE MANY FRIENDS OF Mr. A. H. Moore, of the Standard Brass Foundry, Benoni, South Africa, will learn with pleasure that, accompanied by his wife, he is spending the summer in England. He is at present staying at the Langham Hotel, London.

MR. W. MAIN, of Messrs. Main & Company, Melbourne, Australia, who is at present touring the foundries of Great Britain, would appreciate the receipt of catalogues and pamphlets covering foundry plant and material. They should be sent to the offices of THE FOUNDRY TRADE JOURNAL.

MR. ALFRED R. WINDLE stated at a meeting of the board of the Birmingham Railway Carriage & Wagon Company, Limited, that he felt the time had come for him to resign the chairmanship in favour of a younger man, and nominated Mr. Bernard D. F. Docker in his place. Mr. Windle's resignation was regretfully accepted, and the board tendered to him their thanks for the services he had rendered to the company during the fourteen years of his chairmanship. Mr. Bernard D. F. Docker was elected chairman, and Mr. Alfred R. Windle deputy-chairman.

Obituary.

MR. MATTHEW CHRISTOPHER JAMES, general manager and a director of the Mercantile Dry Dock Company, Limited, Jarrow, was fatally injured recently in a motoring accident near Otterburn, Northumberland. Mr. James was in his 50th year.

Melting Point of Coal Ash.—Dr. F. S. Sinnatt, in a Paper No. 284, on the Industrial Importance of the Heterogeneous Character of Coal Seams, given before the Tokio meeting of the World Engineering Congress, states the melting point of coal ash varies from 1,345 deg. C. (for hand-picked lump) to 1,190 deg. C. for slurry.

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proved beyond all doubt that

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is the joints of the brickwork. It is folly to pay money for good quality Firebricks without purchasing the best refractory for jointing the bricks. **Fireclay is not good enough.** You must have a material which is not only refractory but very strong, and will prevent fluxing at the brick joints and a constant moving of the bricks when contracting or expanding.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Whit-week on Tees-side, according to custom, has been observed as a holiday period in the Cleveland iron trade, and business has been mostly neglected as far as market operations are concerned. Under the existing conditions of restricted demand, however, the break in the routine of buying and selling can hardly affect actual dealings to any great extent, and, with the limited outputs now in force, it is most unlikely that any great increase of stocks has occurred. Buyers still adhere to a policy of hand-to-mouth purchases and refuse to enter into forward contracts. Possibly this policy is dictated to some extent by the industrial uncertainties, but there are usually buyers who are prepared to take a business risk if an inducement be offered. At the moment, however, a waiting policy seems to offer possible advantages, and certainly no risk of loss. It is at least satisfactory to note that shipments from Tees ports during the last month show a slight improvement, having advanced from 14,345 tons in April to 17,878 tons in May. Manufactured iron and steel shipments, on the other hand, only reached 44,955 tons, which is 1,013 tons short of the April figure, so that the aggregate shipments of all classes of iron and steel for May were 62,833 tons, compared with 60,313 tons in April. On the subject of prices, makers are still adamant, fixed quotations to home and foreign buyers being:—No. 1 Cleveland foundry iron, 70s.; No. 3 G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; No. 4 forge, 66s. per ton.

An outstanding event in the East Coast hematite market has been the sale by a Middlesbrough firm of ironmasters of 175,000 tons to Sheffield consumers. The contract price is on a sliding scale, and as delivery is to extend over a period of five years, it does not represent more than the output of one blast furnace. Nominally, the quotation for East Coast mixed numbers is 73s. 6d. and for No. 1 quality 74s. per ton. On the North-West Coast, Bessemer mixed numbers are quoted at 72s. 6d. per ton at works.

LANCASHIRE.—During the past week sellers of foundry pig in local markets have reported freer bookings than of late, although the majority of buyers are confining their commitments rigidly to deliveries during June. At the moment, however, there is nothing in the position of individual foundries in the Lancashire areas to justify extensive forward bookings. Current values are quoted 77s. per ton for Derbyshire and Staffordshire makes of No. 3 and 72s. for forge iron, and from 94s. to 95s. per ton for Scottish brands, all delivered local stations.

THE MIDLANDS.—The position in the Birmingham market for foundry pig has undergone little improvement, demand continuing slow, and buying on very restricted lines. Quotations still rule firmly at 75s. for Northants No. 3 and 78s. for Derbyshire and North Staffordshire No. 3 respectively, with Scotch brands at 94s., all per ton delivered local stations.

SCOTLAND.—Owing to the poor demand for Scotch pig-iron and the resulting increase in stocks, there is more insistent talk of furnaces being put out of blast, but so far no definite action has been taken by any of the makers. In spite of the quietness of the market there is no sign of prices being reduced, and the official quotation for No. 3 Scotch foundry remains at 78s. per ton f.o.t. furnaces.

Finished Iron.

At Birmingham this week there was no improvement in the bar-iron market. The works will be closed for the greater part, or in some cases the whole, of this week. The only satisfactory feature is the comparatively good business for marked bars, the makers of these being in a satisfactory position at the present time. They adhere to the price of £12 10s. at works for this iron. With regard to crown iron, prices continue to vary to a considerable extent, and are anything from £10 to £10 7s. 6d. None of the mills is busy, and they are getting little support for nut and bolt iron, which is quoted at £9 to £9 5s.

Steel.

The position in the semi-finished steel market is irregular, but in general the British works are competing keenly for any business about, and securing a good share of the orders going. Export business continues on a disappointing scale, but there is, perhaps, rather more life in some of the overseas markets than has been apparent for some time. At Sheffield, business in billets, rods and sheets is slow, with no indication of early improvement. The production of open-hearth steel continues to decline. Prices are unaltered, and are as follow:—Siemens acid billets, £9 10s.; basic billets, soft, £6 10s.; medium, £7 12s. 6d.; hard, £8 2s. 6d. to £9 12s. 6d.; wire rods, acid, £12 5s. to £12 10s.; basic, soft, £8; medium hard, £9 15s. to £10; hard, £10 10s. to £11; steel hoops, £10. In the tinplate market quotations are again easy, with coke qualities at 18s. to 18s. 3d., net cash, f.o.b. Welsh ports.

Scrap.

Dealings in foundry scrap material this week present few features of outstanding interest, trade being quiet all round, with prices tending lower. On Tees-side, for example, there was a decline of 1s. per ton, reducing the price of ordinary cast iron to 58s., with machinery quality at 61s. per ton delivered. In Scotland, machinery cast iron is also easier at 66s. 3d. to 67s. 6d., ordinary heavy cast-iron scrap at 62s. 6d., and light cast iron at 50s. to 51s. 3d. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Last week's close of markets for warrant copper again disclosed a further decline in values, with business distinctly in limited volume as concerns actual consumptive account. The demand is still extremely poor, consumers having no need to buy the metal. Their stocks are ample, and consequently their orders are small. The fact that holders offered sparingly gave the market some semblance of steadiness. Independent sellers shaded the price of 13 c., quoted for domestic and export spot electrolytic, although Copper Exporters, Incorporated, maintained their prices.

Closing quotations:—

Cash.—Thursday, £52 15s. to £52 17s. 6d.; Friday, £52 5s. to £52 7s. 6d.; Tuesday, £51 5s. to £51 10s.; Wednesday, £50 15s. to £50 17s. 6d.

Three Months.—Thursday, £53 to £53 2s. 6d.; Friday, £52 10s. to £52 12s. 6d.; Tuesday, £51 10s. to £51 12s. 6d.; Wednesday, £51 2s. 6d. to £51 5s.

Tin.—As anticipated in previous reports, the publication of the monthly statistics, showing an increase of over 3,000 tons in the total visible supply, resulted in weaker values, which fell to the lowest point recorded since 1914, when £120 was touched. A price such as that now ruling puts all the high-cost producing companies out of action. Since 1926 the world's output has risen from 141,504 tons to 188,278 tons last year, and, unless the restriction plan is successful, there is every indication that the current year's production will be little less than in 1929.

Official closing prices:—

Cash.—Thursday, £137 10s. to £137 12s. 6d.; Friday, £139 to £139 5s.; Tuesday, £137 12s. 6d. to £137 15s.; Wednesday, £135 7s. 6d. to £135 10s.

Three Months. — Thursday, £139 10s. to £139 12s. 6d.; Friday, £141 2s. 6d. to £141 5s.; Tuesday, £139 12s. 6d. to £139 15s.; Wednesday, £137 7s. 6d. to £137 10s.

Spelter.—Only a quiet demand was in evidence in this metal during the current week, and values generally indicate a downward tendency. The trade demand has not improved, but with little liquidation and slightly improved reports from the Continent the position is steadier.

Daily fluctuations:—

Ordinary.—Thursday, £16 15s.; Friday, £16 15s.; Tuesday, £16 11s. 3d.; Wednesday, £16 10s.

Lead.—The market for soft foreign pig continues extremely quiet. The demand remains small and trading occasionally has been almost at a standstill.

The week's prices have been:—

Soft Foreign (Prompt).—Thursday, £17 18s. 9d.; Friday, £18 1s. 3d.; Tuesday, £18; Wednesday, £18.

Publication Received.

The Garrett Gazette, Vol. I, No. 1. Published by Messrs. Richard Garrett & Sons, Limited, of Leiston, Suffolk.

This is the first issue of a monthly publication destined to be of service to users of heavy haulage vehicles. The first issue is an eight-page booklet, and on page 3 is given an outline of the history of the works, which claim to be second oldest engineering establishment in Great Britain, having been founded in 1778 by Richard Garrett, whose great-grandsons form the present directorate. The firm is associated with Agricultural & General Engineers, Limited, Aldwych, London, W.C.2.

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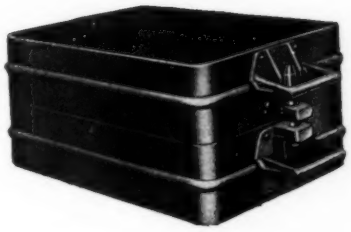

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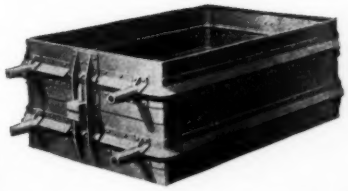

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They are light and easy to handle.
Cannot crack or break.
Cannot spring.
Strong, Rigid,
Durable and
Permanently
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BY ADOPTING STERLING BOXES IN YOUR FOUNDRY,

You will halve your moulding costs. You will increase production per man per hour, and reduce your box maintenance costs. You will turn out more accurate castings and thereby reduce your scrap and reject accounts. You will considerably reduce your fettling costs and put money into your pocket that is now running to waste.

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BEDFORD.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	50	15	0
Three months	51	2	6
Electrolytic	60	10	0
Tough	59	0	0
Best selected	59	10	0
Sheets	87	0	0
India	72	0	0
Wire bars	61	0	0
Do. June	61	0	0
Do. July	61	0	0
Ingot bars	61	0	0
H.C. wire rods	63	0	0
Off. av. cash, May	53	5	0 15/28
Do., 3 mths., May	53	1	5 17/28
Do., Sttlmnt., May	53	4	2 5/112
Do., Electro, May	60	9	6 5/112
Do., B.S., May	59	10	3½
Do., wire bars, May	61	8	2 5/112
Solid drawn tubes			12½d.
Brazed tubes			12½d.
Wire			8½d.

BRASS.

Solid drawn tubes	11d.
Brazed tubes	12½d.
Rods, drawn	10½d.
Rods, extd. or rlld.	6½d.
Sheets to 10 w.g.	9½d.
Wire	9½d.
Rolled metal	8½d.
Yellow metal rods	6½d.
Do. 4 × 4 Squares	7½d.
Do. 4 × 3 Sheets	7½d.

TIN.

	£	s.	d.
Standard cash	135	7	6
Three months	137	7	6
English	136	15	0
Bars	138	15	0
Straits	137	12	6
Australian	136	17	6
Eastern	142	0	0
Banca	141	12	6
Off. av. cash, May	144	18	0 9/112
Do., 3 mths., May	146	15	10 11/112
Do., Sttlmt., May	144	17	6

SPELTER.

	£	s.	d.
Ordinary	16	10	0
Remelted	15	10	0
Hard	13	15	0
Electro 99.9	18	17	6
English	16	17	6
India	15	0	0
Zinc dust	22	0	0
Zinc ashes	4	5	0
Off. aver., May	18	1	11 3/8
Aver., spot, May	16	12	9 9/32

LEAD.

	£	s.	d.
Soft foreign ppt.	18	0	0
English	19	10	0
Off. average, May	17	16	6¾
Average spot, May	17	15	10 11/112

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	27	0	0
Do. V.M. ex-whf.	25	10	0
Rods	30	0	0
Boiler plates	22	0	0
Battery plates	24	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	40	0	0
Chinese	26	10	0
Crude	20	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 17 6
45/50%	£11 10 0
75%	£18 10 0
Ferro-vanadium—	
35/50%	12/9 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/2 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£16 0 0
Ferro-tungsten—	
80/85%	2/10 lb.
Tungsten metal powder—	
98/99%	3/1 lb.
Ferro-chrome—	
2/4% car.	£30 10 0
4/6% car.	£23 7 6
6/8% car.	£22 10 0
8/10% car.	£22 0 0
Ferro-chrome—	
Max. 2% car.	£33 10 0
Max. 1% car.	£37 17 6
Max. 0.70% car.	£39 15 0
70% carbon-free	11d. lb.
Nickel—99% cubes, or pellets	£175 0 0
Ferro-cobalt	9/6 lb.
Aluminium 98/99%	£95 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£11 15 0
76/80% packed	£12 15 0
76/80% export	£11 10 0
Metallic manganese—	
94/96% carbonless	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 2
Finished bars, 18% tungsten	£0 3 0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel	2	17	6	to 2	18	6
Bundled steel and shrngs.	2	12	6	to 2	17	6
Mixed iron and steel	2	12	0	to 2	14	0
Heavy cast iron	2	16	0	to 2	17	6
Good machinery for foundries	2	17	0	to 2	19	0
Cleveland—						
Heavy steel			2	10	0	
Steel turnings			2	6	6	
Cast-iron borings			2	1	0	
Heavy forge			3	12	0	
W.I. piling scrap			3	7	6	
Cast-iron scrap	2	18	0	to 3	1	0
Midlands—						
Ord. cast-iron scrap			3	5	0	
Heavy wrought			3	5	0	
Steel turnings			1	12	6	
Scotland—						
Heavy steel			2	15	0	
Ordinary cast iron			3	2	6	
Engineers' turnings			2	5	0	
Cast-iron borings			2	3	6	
Wrought-iron piling			3	12	6	
Heavy machinery			3	6	6	

London—Merchants' buying prices delivered yard.

Copper (clean)	£47 0 0
Brass	£35 0 0
Lead (less usual draft)	£16 0 0
Tea lead	£12 10 0
Zinc	£10 0 0
New aluminium cuttings	£60 0 0
Braziery copper	£44 0 0
Gunmetal	£44 0 0
Hollow pewter	£102 0 0
Shaped black pewter	£78 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	70/-
Foundry No. 3	67/6
Foundry No. 4	66/6
Forge No. 4	66/-
Hematite No. 1	74/-
Hematite M/Nos.	73/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	85/6
„ d/d Birm.	90/6
Midlands—	
Staffs. common*	—
„ No. 4 forge*	73/6
„ No. 3 fdry.*	78/6
Shrops. basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	70/-
„ fdry. No. 3*	75/-
Derbyshire forge*	73/6
„ fdry. No. 3*	78/6
„ basic*	—
*d/d Black Country dist.	
Scotland—	
Foundry No. 1	80/6
„ No. 3	78/-
Hem. M/Nos.	81/-
Sheffield (d/d district)—	
Derby forge	68/6
„ fdry. No. 3	73/6
Lincs. forge	70/-
„ fdry. No. 3	75/-
E.C. hematite	88/-
W.C. hematite	88/-
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	72/-
„ fdry. No. 3	77/-
Staffs foundry No. 3	77/-
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	94/6
Glengarnock, No. 3	—
Gartsherrie, No. 3	94/6
Monkland, No. 3	94/6
Shotts, No. 3	94/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)				10	15	0
Nut and bolt iron	9	0	0	to 9	5	0
Hoops				10	15	0
Marked bars (Staffs) f.o t.				12	10	0
Gas strip				10	15	0
Bolts and nuts, ¾ in. × 4 in.				15	5	0
Steel—						
Ship plates	8	15	0	to 8	17	6
Boiler plts.	9	15	0	to 10	10	0
Chequer plts.				10	12	6
Angles				8	7	6
Tees				9	7	6
Joists				8	10	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ¾ in. (Untested)				8	0	0
						and upwards
Flats—8 in. wide and over				8	12	6
„ under 8 in. and over 5 in.				8	17	6
Rails, heavy				8	10	0
Fishplates				12	0	0
Hoops (Staffs)	9	5	0	to 9	15	0
Black sheets, 24 g.				9	15	0
Galv.cor.shts., 24g.				11	17	6
Galv. fencing wire, 8g. plain				12	0	0
Billets, soft	6	0	0	to 6	10	0
Billets, hard	7	10	0	to 8	0	0
Sheet bars	5	15	0	to 6	5	0
Tin bars	6	2	6	to 6	5	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/1½
Sheet to 10 w.g.	1/2
Wire	1/3½
Rods	1/2½
Tubes	1/6½
Castings	1/1½

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	19.76
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.00
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80%	94.00
O.-h. rails, h'y, at mill	43.00
Billets	33.00
Sheet bars	33.00
Wire rods	36.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.75
Tank plates	1.70
Beams, etc.	1.70
Skelp, grooved steel	1.80
Skelp, sheared steel	1.80
Steel hoops	2.20
Sheets, black, No. 24	2.55
Sheets, galv., No. 24	3.20
Sheets, blue an'l'd, No. 13	2.15
Wire nails	2.15
Plain wire	2.30
Barbed wire, galv.	2.80
Tinplates, 100-lb. box	$5.25

COKE (at ovens).

Welsh foundry	27/6
„ furnace	17/6 to 22/6
Durham and Northumberland—	
„ foundry	14/6 to 15/6
„ furnace	14/6
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	18/1½
„	28×20 „	36/3
„	20×10 „	26/4½
„	18¾×14 „	18/10½
C.W.	20×14 „	16/6
„	28×20 „	33/6
„	20×10 „	23/6
„	18¾×14 „	17/-
Terneplates	28×20	32/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to	£7	10	0
Bars, hammered, basis	£17	10	0	to	£18	10	0
Bars and nail-rods, rolled, basis	£15	17	6	to	£16	15	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£32	0	0	to	£33	0	0
Faggot steel	£20	0	0	to	£24	0	0
Bars and rods dead soft, steel	£11	0	0	to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ½ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	62½%	47½%
Water ..	58½%	42½%
Steam ..	55%	37½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
June	5 ..	52	15	0	dec.	2/6
,,	6 ..	52	5	0	,,	10/-
,,	9 ..	—	—	—	—	—
,,	10 ..	51	5	0	dec.	20/-
,,	11 ..	50	15	0	,,	10/-

Electrolytic Copper.

		£	s.	d.		
June	5 ..	60	10	0	No change	
,,	6 ..	60	10	0	,,	,,
,,	9 ..	—	—	—	—	—
,,	10 ..	60	10	0	No change	
,,	11 ..	60	10	0	,,	,,

Standard Tin (cash).

		£	s.	d.		
June	5 ..	137	10	0	inc.	50/-
,,	6 ..	139	0	0	,,	30/-
,,	9 ..	—	—	—	—	—
,,	10 ..	137	12	6	dec.	27/6
,,	11 ..	135	7	6	,,	45/-

Tin (English ingots).

		£	s.	d.		
June	5 ..	138	5	0	inc.	45/-
,,	6 ..	140	0	0	,,	35/-
,,	9 ..	—	—	—	—	—
,,	10 ..	138	15	0	dec.	25/-
,,	11 ..	136	15	0	,,	40/-

Zinc Sheets (English).

		£	s.	d.		
June	5 ..	27	0	0	No	change
,,	6 ..	27	0	0	,,	,,
,,	9 ..	—	—	—	—	—
,,	10 ..	27	0	0	No	change
,,	11 ..	27	0	0	,,	,,

Spelter (ordinary).

		£	s.	d.		
June	5 ..	16	15	0	inc.	7/6
,,	6 ..	16	15	0	No	change
,,	9 ..	—	—	—	—	—
,,	10 ..	16	11	3	dec.	3/9
,,	11 ..	16	10	0	,,	1/3

Lead (English).

		£	s.	d.		
June	5 ..	19	10	0	No	change
,,	6 ..	19	10	0	,,	,,
,,	9 ..	—	—	—	—	—
,,	10 ..	19	10	0	No	change
,,	11 ..	19	10	0	,,	,,

AVERAGE MONTHLY PRICES OF STEEL SHIP ANGLES (NORTH OF ENGLAND).

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1896	4 15 0	4 17 6	5 0 0	5 0 0	5 0 0	4 17 6	4 17 6	4 17 6	4 17 6	5 0 0	5 7 6	5 7 6	4 19 9½
1897	5 7 6	5 7 6	5 7 6	5 5 0	5 0 0	5 0 0	5 2 6	5 2 6	5 2 6	5 2 6	5 0 0	5 5 0	5 3 5½
1898	5 5 0	5 5 0	5 5 0	5 7 6	5 13 9	5 15 0	5 15 0	5 15 0	5 17 6	6 0 0	6 5 0	6 7 6	5 14 3
1899	6 10 0	6 12 6	6 15 0	6 15 0	6 17 6	6 17 6	7 0 0	7 0 0	7 5 0	7 5 0	7 12 6	7 15 0	7 0 5
1900	7 15 0	8 0 0	8 2 6	8 5 0	8 5 0	8 7 6	8 7 6	8 2 6	8 2 6	8 0 0	7 10 0	7 10 0	8 0 7½
1901	6 15 0	6 12 6	6 5 0	6 0 0	6 0 0	5 10 0	5 15 0	5 17 6	6 0 0	5 17 6	5 17 6	5 15 0	6 0 5
1902	5 12 6	5 10 0	5 10 0	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 11 8
1903	5 6 3	5 6 3	5 7 6	5 12 6	5 12 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 0 0	5 8 0
1904	5 0 0	4 17 6	5 2 6	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 0 0	5 0 0	5 0 0	5 5 0	5 2 6
1905	5 5 0	5 7 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 12 6	6 2 6	6 12 6	6 12 6	5 14 4½
1906	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	7 2 6	6 13 4
1907	6 17 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	6 12 6	6 12 6	7 0 5
1908	6 2 6	6 2 6	6 2 6	5 17 6	5 17 6	5 17 6	5 17 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 16 3
1909	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 9 7
1910	5 16 3	5 17 6	5 17 6	6 1 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 7 6	6 7 6	6 7 6	6 2 3½
1911	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 9 0	6 7 6	6 7 8½
1912	6 16 3	6 17 6	6 17 6	7 5 0	7 7 6	7 7 6	7 7 6	7 12 6	7 12 6	6 15 6	7 14 6	7 17 6	7 4 4½
1913	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 11 6	7 7 6	6 15 6	6 7 6	6 2 6	7 8 11½
1914	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	5 15 0	5 15 0	6 15 0	7 0 0	7 0 0	7 1 3	7 5 0	6 8 7½
1915	7 17 0	8 5 0	8 17 6	9 5 0	9 5 0	9 15 0	9 15 0	9 15 0	9 15 0	9 15 0	10 15 0	10 15 0	9 8 3½
1916	11 3 1½	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1917	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1918	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 0½
1919	11 2 6	13 12 6	13 12 6	17 2 6	17 2 6	17 1 3	17 0 0	17 15 0	17 15 0	17 15 0	17 17 6	18 5 0	16 1 9
1920	19 10 0	20 0 0	21 10 0	22 0 0	23 5 0	24 0 0	24 0 0	24 0 0	24 15 0	24 10 0	24 0 0	24 0 0	22 19 2
1921	22 10 0	20 12 6	19 0 0	17 10 0	17 10 0	16 6 0	14 10 0	14 3 4	13 10 0	11 15 0	10 0 0	9 12 6	15 11 7
1922	9 17 6	10 0 0	10 0 0	10 0 0	10 0 0	9 17 6	9 10 0	8 15 7½	8 14 0	8 12 6	8 12 6	8 12 6	9 7 8½
1923	8 18 1½	9 1 3	9 14 0	10 0 0	10 0 0	10 0 0	9 8 9	9 9 6	9 10 0	9 8 9	9 11 6	9 18 9	9 11 8½
1924	10 0 0	9 18 1½	9 17 6	9 17 6	9 17 2	9 11 3	9 15 0	9 15 0	9 9 4½	9 6 6	9 5 0	9 13 1½
1925	9 2 0	9 0 11½	9 0 0	8 15 9	8 10 3½	8 9 0½	8 6 3	8 2 6	7 19 0½	7 12 3	7 5 0	7 2 6	8 5 5½
1926	7 2 6	7 2 6	7 2 6	7 3 4	7 2 6	7 3 9	7 7 6	7 8 5½	7 9 0	7 12 6	7 16 3	8 0 6	7 7 7½
1927	7 16 9	7 17 6	7 17 6	7 14 8½	7 18 9	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 14 1½
1928	7 12 6	7 14 9	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 16 10¼
1929	7 17 6	7 17 6	7 17 6	7 17 6	8 0 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 5 0	8 1 1
1930	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	—	—	—	—	—	—	—	—

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